CANADIAN GEOGRAPHICAL JOURNAL

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THE CANADIAN GEOGRAPHICAL SOCIETY

OTTAWA, CANADA

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The Practical and Commercial Value of Astronomy

by C. S. BEALS

Introduction

One of the questions most frequently asked by visitors[1] to the Dominion Observatories is of what practical or commercial value is the astronomical work being done at those institutions. Since the Observatories at Ottawa and Victoria are owned by the people of Canada and operated by the Dominion Government from funds derived from general taxation, this is a fair question and one that deserves a clear and accurately reasoned answer. This article represents an attempt to give such an answer. In treating the subject a brief summary is first given, outlining in a general way some of the more important practical uses of astronomy, followed by a more extended discussion, which is partly of a historical character, of the contribution which astronomical research has made to the practical science of the present day.

Summary

The Dominion Observatory at Ottawa maintains a time service of the highest accuracy for the purpose of regulating the functioning of government departments, of

[1]Approximately 35,000 members of the general public visit the two institutions at Ottawa and Victoria during the course of a normal year.

At top: Dominion Astrophysical Observatory, Victoria, British Columbia. This photograph shows the steel dome in which is housed Canada's 73-inch reflecting telescope, one of the largest and finest now in operation. Founded in 1918 by the late Dr. J. S. Plaskett, this institution has been devoted to astronomical research for the past 26 years. Most of the observations are made with the aid of a stellar spectrograph, and over 34,000 photographs of the spectra of individual stars are now in its collection. Present Director is Dr. J. A. Pearce. Contributions to astronomy for which he and his colleagues are responsible include stellar motions, structure of the galaxy, star temperatures, interstellar matter, and numerous applications of astronomy to atomic and molecular structure. Fig. 1

transportation systems and all the aspects of modern life which depend upon accurate time. A daily time signal, 12h 59m 30s to 1:00 p.m. Eastern Standard Time, accurate to a small fraction of a second and available to the ordinary radio set, is broadcast by the C.B.C. radio system for the purpose of regulating time systems in all parts of the Dominion. In addition, time signals are continuously broadcast 24 hours a day by short wave transmitter for the purpose of providing time accurate to a few hundredths of a second for the determination of longitude in surveying or in navigation by sea or air.*

The utility of such a service is too obvious to be questioned, but it is sometimes not generally recognized that the only ultimate source of accurate time is to be found in astronomical observations carried on continuously from night to night and correlated by clocks of high accuracy maintained under rigidly controlled physical conditions.

Another branch of the service is the magnetic survey, whose practical necessity arises from the fact that in most areas the magnetic compass does not point true north. The magnetic pole of the earth is separated from the true north pole by many hundreds of miles, and this fact, combined with local differences in the magnetic characteristics of the earth's crust, produces such errors in the directions given by the compass as would make it useless for purposes of navigation or surveying unless suitable tables of corrections were available. The magnetic survey is largely for the purpose of obtaining values of this correction, commonly called the magnetic declination,[2] for all parts of the country and particularly for the coastal areas where they are required by navigators. As in the case of the time service, the utility of the service is unquestioned and its astronomical implication is of course found in the fact that astronomical observations are necessary in order to determine true north.

One of the most important activities of the Dominion Observatory at Ottawa is the study of geophysics[3] which makes use both of the variation of gravity in different localities and the records of earthquake shocks for a determination of the characteristics of the earth's crust. In Canada a great deal of effort has been devoted to the application of geophysics to mining. One branch of the work concerns geophysical methods of prospecting and the location of ore bodies by the methods of gravity or seismology. Another part of the work is concerned with safety measures in the mines, in particular with the prediction of such breakdowns in the walls or galleries of mines as are commonly referred to as rockbursts. The attack made on this problem by Dominion Seismologists has met with considerable success and is making a valuable contribution to the safety of life and property in the mines.

A large part of the work of the two Dominion Observatories is concerned with a study of the motions, positions and physical characteristics of the heavenly bodies. While this type of work has less immediate practical application than those already mentioned, it is probably more significant in the long run because of the unique character of the contribution which it is making to the general progress of physical science. The terrestrial science of physics and, to a lesser extent, that of chemistry, suffers certain very definite limitations imposed by the restricted range of temperatures, pressures and densities available for study on earth. In addition, the study of gravitation and its effects is hindered by the fact that earthly experimentation is necessarily concerned with bodies of relatively small mass and those whose motions are restricted by the nature of their terrestrial environment.

These handicaps are, to a considerable extent, overcome by the methods of observation and research developed by astronomy. These methods make it possible to observe the behaviour of matter under conditions which cannot be duplicated on earth. The study of the motions of stars and planets in free space under their forces of mutual gravitational attraction has led to revolutionary advances in the science of mechanics,

*To Mr. R. M. Stewart, Dominion Astronomer, belongs the credit for developing Canada's time service.

[2] The magnetic declination varies continuously from year to year so that repetition is necessary to keep the tables up to date.
[3] Geophysics is the physics of the earth.

while, during the past few decades, the study of the atmospheres of the stars at temperatures between 4,000° F. and 200,000° F, the study of stellar interiors at temperatures of 50,000,000° F, and the study of interstellar matter at temperatures of 440° below zero Fahrenheit has led to advances in knowledge of atomic and molecular structure which are of the greatest practical importance, and without which terrestrial physics could not make the contribution to the arts of war and peace which it is making to-day. The detailed implications of these discoveries are too numerous and intricate to be included in a brief summary, and it is proposed to deal with some of them in greater detail in the discussion which follows.

The Birth of Physical Science: For some inexplicable reason the stars were deemed worthy of precise study and observation long before such attention was paid to bodies on the surface of the earth. As a consequence, astronomy reached a fairly mature state of development before terrestrial physics was born. Eventually scientific interest in the heavens begat similar interest in objects on earth and the methods of careful observation and precise measurement developed by astronomers were applied to terrestrial science as well. It is certainly no coincidence that the group of men who may be said to have founded modern physics, Kepler, Galileo, Huyghens and Newton, were all astronomers and that most of the physical principles enunciated by them were derived from studies of the motion of the planets around the sun. During subsequent years the science of terrestrial physics quickly came to stand on its own feet and to expand by its own methods, but, in spite of that fact, physics and astronomy have remained indispensable to one another up to the present day and are likely to remain so in any future which can now be foreseen.

Astronomy the Timekeeper: The affairs of daily life have, of necessity, always been regulated by the rising and setting of the sun, and from very early times observations of other heavenly bodies have been used to regulate the calendar and to fix the seasons of the year in their relation to one another. The ancients experienced difficulty with the calendar owing to the fact that the day, the month and the year are not simple multiples of one another. This was clearly recognized by Julius Caesar as early as 46 B.C. and with the aid of the astronomers, Lilius and Clavius, he introduced a calendar which approximated to that of the present day. It was not until 1582, however, that astronomical observations and calculations were sufficiently precise to give the calendar its present-day accuracy. The confusion into which the Roman calendar had fallen prior to 46 B.C., as a result of faulty calculations as well as to legal and political manipulations, is in itself sufficient witness to the value of an accurate science of astronomy. The necessity for accurate timekeeping in the more complex modern world is of course much greater, and most modern nations including Canada maintain observatories which are able to supply time accurate to a few hundredths of a second.

Before leaving the subject of time, some mention must be made of its use in the physical laboratory. Physicists do not, as a rule, obtain their time directly from the stars, but most of the timekeeping devices in use by them were originally developed for astronomical purposes, and even such a device as the electrical clock driven by a synchronous motor must eventually go back to astronomical methods to standardize its rate. Since time appears as a variable in the equations from which many fundamental physical constants (e.g. the velocity of light, first measured by purely astronomical methods) are derived, an accurate and precise science of physics is impossible without astronomy.

Surveying and Navigation: It comes as a surprise to many that the only dependable way of fixing a position on the earth's surface is by astronomical observations. Landmarks may be destroyed, rivers may change their courses and shore lines may be washed away by the sea, but latitude and longitude are sufficiently definite quantities to form the basis of permanency. No legal quibble can alter the position of the 49th parallel, but, in the absence of accurate astronomical

methods for fixing the position of this invisible line, the possibilities for dispute offered by 2,000 miles of such a boundary are considerable and unlikely to be overlooked by those whose interests would be served by adjustments of a major or minor character. Almost certainly the absence of disagreement concerning this boundary over the past hundred years is due in large measure to the existence of means of fixing the position of the line which supersede the methods of purely legal or political compromise and adjustment. No one in a position of national responsibility is likely to underestimate the value of a science which makes it possible to avoid costly and troublesome international disputes.

The determination of latitude and longitude at sea is not essentially different from the same process on land, but, owing to the unstable character of a ship's deck, very different instruments are used and the technique of navigation is both an art and a science in itself. The importance of accuracy in navigation gives additional emphasis to the commercial value of astronomy. The loss of a single large ship with a valuable cargo as a result of faulty longitude due to inaccurate time might well involve a financial loss greater than the total expenditure on Canadian astronomy during several decades. Similar considerations prevail in the matter of air navigation which will assume greater and greater importance as time goes on. The safety of long-range flights, whether over the ocean or over featureless land surfaces, are dependent on accurate star positions and time. While some of the earlier ocean flights were made without benefit of astronomy, a modern aeroplane with its passengers and crew is too valuable to entrust to any but the most accurate methods of astronomical navigation. Such methods, whether in navigation or surveying, are finally entirely dependent upon accurate star positions, laboriously determined by such observatories as are maintained in Canada and in many other countries.

Mechanics and Engineering: The science of mechanics on which all engineering practice is based had its origin in the astronomical discoveries of the sixteenth and seventeenth centuries. The honour of its founding must be divided among the following astronomers: Copernicus, 1473-1543, who gave the first generally correct idea of the motions of the planets in his theory that they revolved in circular orbits around the sun; Tycho Brahe, 1546-1601, who provided the first observations of sufficient accuracy for a complete test of the theory; Kepler, 1571-1630, who used Tycho Brahe's observations to show that the planetary orbits were ellipses rather than circles; Galileo, 1564-1642, who first realized the possibilities of the telescope and of the pendulum and who was among the first to experiment with falling bodies; and, finally, Sir Isaac Newton, 1642-1727, whose marvellous synthesis of his own work with that of his predecessors in the field of planetary motion made possible his discovery of the law of gravitation, the enunciation of his three laws of motion and the placing of modern science on the road that has inevitably led to the great advances of the present day.

So complete is the dependence of modern engineering upon the physical principles discovered by these men that it would be impossible to design a high-speed engine, to construct a piece of heavy artillery or indeed to carry out any major engineering project without making use of the laws of motion which originated largely from the interpretation of purely astronomical observations.

Mathematical Methods: The contribution made by astronomical science to mathematics is closely associated with the contribution to mechanics which has just been mentioned. As the accuracy of astronomical observations was continually refined the need was felt for more powerful mathematical methods with which to interpret them. The result was the discovery of the differential and integral calculus which was shared by Newton and Leibniz and which played an important part in the discovery of the laws of motion. This discovery not only forms the basis of all advanced mathematics but it has proved to be such an immensely powerful tool for research in terrestrial physics that astronomy would have paid for itself many times over by the part which it played in stimulating the discovery of the

calculus alone. Not only was astronomy involved in the initial discovery of the calculus but the continually increasing number of astronomical observations and the complexity of the problems which they have presented have led to many additional mathematical discoveries, most of which have sooner or later found practical application in physical science. The process is in fact still going on and is likely to continue so long as there are major problems in astronomy which remain unsolved.

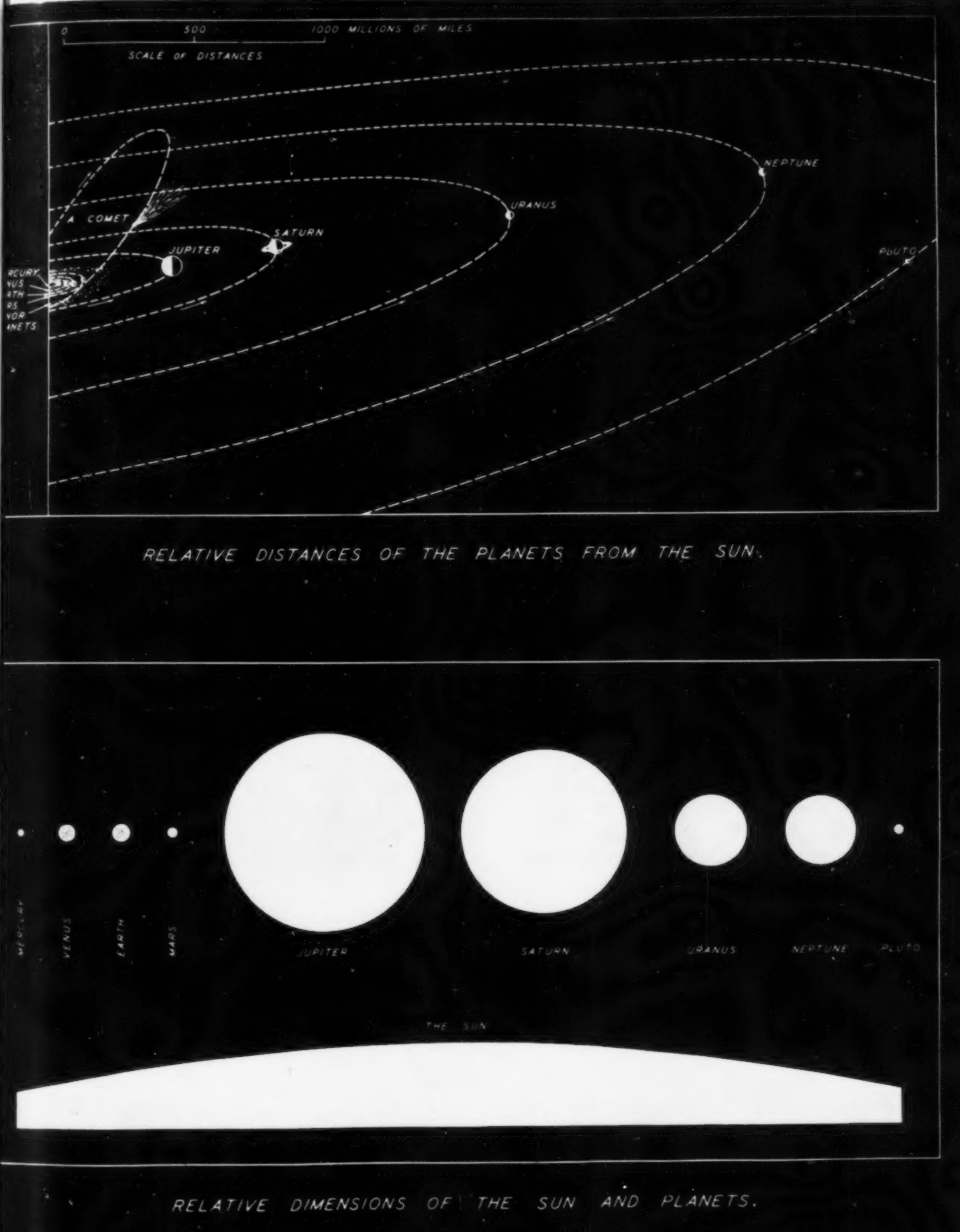
Optics and Optical Instruments: Another great contribution made to physical science by astronomy is in the field of optics and optical instruments. The refracting telescope was first developed to its present form for astronomical purposes, the reflecting telescope was invented by Newton for astronomical observation, while present-day methods for the grinding, polishing and testing of optical surfaces and the coating of mirrors with reflecting metallic films are largely a product of the astronomical profession. Moreover, as is the case with mathematics, the process of improving optical methods still continues as is evidenced by the recent invention of the Schmidt camera for taking astronomical photographs and the development of evaporation methods for the coating of mirrors with metallic surfaces.

One optical instrument, which in its inception owed its development largely to astronomy, deserves special mention and that is the spectroscope. This instrument, which was at first mainly used for the study of the light of the sun and stars, has found wide application in physics and chemistry and has proved to be the most powerful single instrument of research ever devised by man. Not only has it led to fundamental advances in our knowledge of atomic and molecular structure but it has innumerable immediate practical applications, including the analysis of ore samples, the determination of impurities in foods, the estimation of the vitamin content of fish oils and the determination of the temperatures involved in explosions.

The Photoelectric Cell: An interesting by-product of modern astronomical research is the photoelectric cell. While the original discovery of the photoelectric effect (the ejection of electrons from a metallic surface when light falls upon it) was made last century in the physical laboratory, the development of the photoelectric cell as a useful implement of research was due to astronomers who were looking for a rapid and accurate method of measuring the light variation of faint stars. Once developed, this light measuring device was taken over by industry and, as the "electric eye" of commerce, has found an astonishing number of practical applications. The most important is in the motion picture industry where a photoelectric cell is used to pick up the sound frequencies impressed photographically on the edge of the film and translate them into audible sounds for the theatre audience. Other familiar uses of the electric eye include opening doors, counting merchandise, operating burglar alarms, testing blood, analysing the colours of textiles and determining whether the crank case oil of a motor car needs changing.

Atomic Structure: The outstanding contribution made to practical science by that branch of astronomy known as astrophysics is in the field of atomic structure. The multitudes of absorption lines exhibited by the spectra of the sun and stars, the remarkable differences in spectra between the so-called "early" and "late" type stars[4], the appearance of absorption lines due to matter in interstellar space and the fact that many astronomical bodies exhibit emission as well as absorption lines[5] have combined to focus the attention of many of the large observatories on the problem of the analysis of spectra and the interpretation of spectra in terms of atomic structure. Early in the present century, as a result partly of astronomical observations and partly of laboratory studies, the proposal of the Bohr theory of the hydrogen atom initiated the attack on the problem. Later, in the early 1920's, two outstanding astrophysicists, A. Fowler in England and H. N. Russell in the United States, began the study of more complex spectra. The work was taken up by physical

[4]Early type stars are hot, ranging from 200,000° F. to 20,000° F., while late type stars are cool, 10,000° F. to 2,000° F.
[5]In Fig. 4 the star lines are absorption lines; the iron comparison, emission.



The Solar System. It has taken over 500 years of astronomical research to accumulate the information contained in this diagram. The scale of the diagram is indicated by the fact that the largest planet, Jupiter, is 88,000 miles in diameter, and is 483,000,000 miles from the sun. The earth takes a year to make a complete revolution in its orbit about the sun, while Jupiter takes twelve years. The time for a complete revolution of Pluto, the most distant planet, is 248 years. Some of the most important laws of mechanics on which the science of engineering is based were discovered by studying the motions of the planets. Fig. 2

laboratories and observatories all over the world, and, in scarcely more than a decade, the spectra of a majority of the common elements had found a satisfactory interpretation in terms of the external structure of the atom. An important part in this work was taken by the Dominion Astrophysical Observatory in Victoria where work on the spectra of the hotter stars was begun in 1918 and where a large amount of data on the higher ionizations of the atoms of helium, carbon, nitrogen, oxygen, silicon and magnesium had been accumulated. Since by observing a number of stars of different spectral type the stellar absorption lines could be observed over a considerable range of temperature, the astrophysical data in many instances provided the clue necessary for the interpretation of the spectra in terms of atomic structure. In this connection it is interesting to record that the element helium was discovered in the spectrum of the sun before it was known on earth, and that many lines found in the spectra of the stars which are essential to a full understanding of the structure of the lighter atoms have never been and probably never will be observed in the physical laboratory. Particular examples are found in the emission lines due to forbidden transitions[6] in nebulae associated with hot stars and the highly ionized iron lines (up to the tenth ionization[7]) which have been identified in the spectrum of the sun's corona.

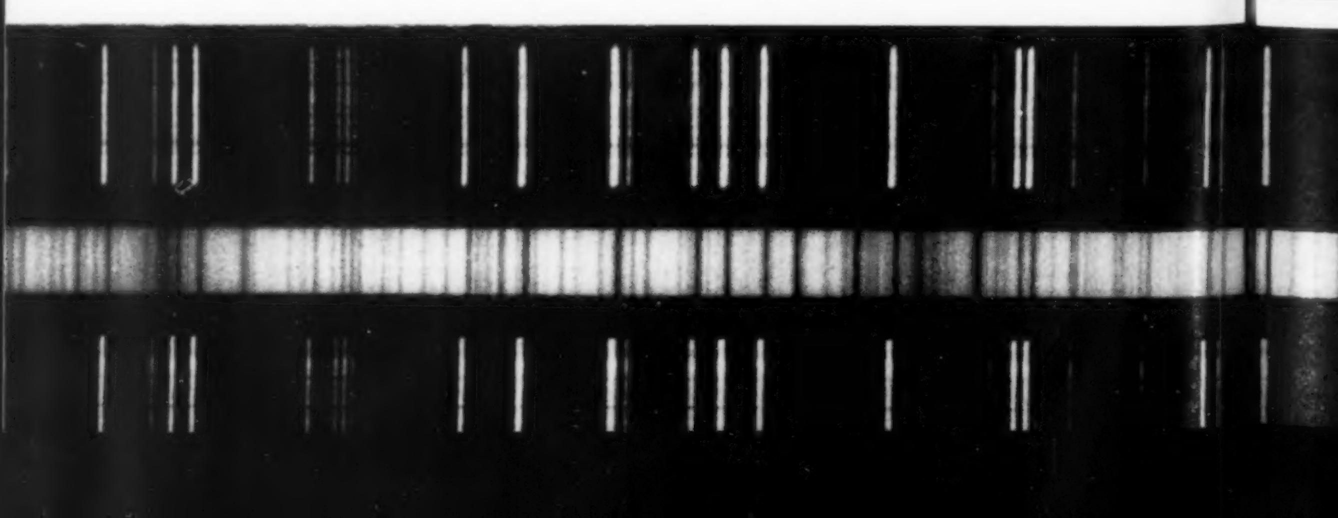
In the field of molecular structure also, the Canadian Observatories have played an important part through an active study of the spectrum of comets as well as of material in interstellar space. Owing to the rarefied nature of interstellar space it is possible to observe the behaviour of a number of common molecules in the gaseous form at temperatures close to absolute zero, a condition which would be impossible of realization in the laboratory.

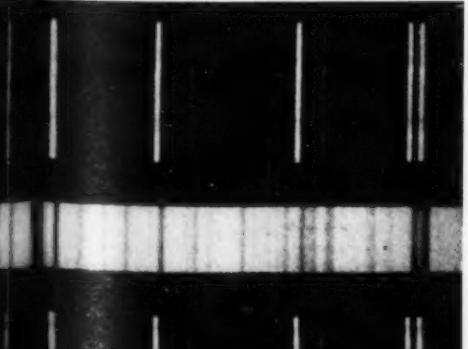
The ultimate practical and commercial importance of these developments is found in the fact that almost all advances in modern physics are based upon our knowledge of atomic and molecular structure. It is, in fact, difficult to find a modern technical device that does not owe something either directly or remotely to a modern knowledge of atoms or molecules. Foremost in any list of such devices would come such tools or instruments as make use of high vacuum. These include radio amplification tubes, X-ray tubes, neon and other advertising signs, fluorescent lighting units, electrocardiographs, television tubes and a host of others, the enumeration of which would become tedious if carried out in detail. The rapidity with which such devices are being adapted to the needs of industry and war makes it abundantly clear that any worthwhile contribution from whatever source to our knowledge of the ultimate units of matter is an invaluable contribution to the practical science of the future.

New Physical Principles: In addition to such advances in science as have already found practical application in one form or another, modern astrophysical observations have helped in the development of certain new principles of physics whose major applications lie in the future. One of these is the disintegration and synthesis of atomic nuclei. For many years the splitting of the atomic

[6] "Forbidden" lines do not occur in laboratory sources but are frequently observed in celestial objects where the gases are at very low densities.

[7] Ionization, the removal of an electron from an atom. The atom has a different spectrum for each electron removed.





Above: The Ring Nebula in Lyra. The central star of this photograph has a temperature of 200,000° Fahrenheit, and it is surrounded by a shell of gas 2,000,000,000,000 miles in diameter. The density of this gas is lower than the best vacuum that can be obtained on earth. Observations of the behaviour of the gases in the shell under the influence of radiations from the high-temperature star has resulted in important new discoveries concerning the nature of atoms. Fig. 3

Left: Spectrum of the star Procyon. Here we see the light of the star Procyon broken up into a spectrum. This is done with the aid of a spectrograph, an instrument which analyses the light from any bright object, breaking it up into a pattern of lines such as that shown here. The spectrum of the star is shown in the centre, while the array of lines top and bottom is due to an electric arc between iron poles. Each element has its own characteristic spectrum which is easily identified, and the iron spectrum, shown here, is frequently used as a comparison because of its numerous lines. Note that each of the bright lines of iron has its counterpart among the dark lines of the star spectrum. The star also has lines due to many other elements. A study of the spectrum tells us what atoms are present in the star, its temperature and pressure and, in many cases, its diameter and mass. The slight displacement of the star lines relative to those of the iron arc in this figure indicates that the star is receding from us. (Range of spectrum λ3785 to λ3880.) Fig. 4 Photograph by C. S. Beals

nucleus was an unfulfilled dream of physicists, but it has recently been accomplished in the laboratory both by the use of fast particles from radio-active materials and with the aid of the newly invented cyclotron which is able to produce atomic velocities comparable with those of the α-particles from radium. The greatest recent impetus to this field of physics has, however, been given by the successful attempts of Bethe and his collaborators to account for the source of solar and stellar energy.[8] Basing his work on astrophysical data relating to the masses, luminosities and internal temperatures of the stars, Bethe has shown that a series of nuclear "chemical" reactions involving the lighter elements such as hydrogen, helium, carbon, oxygen, and nitrogen at temperatures of the order of 50,000,000° is able to give a completely satisfactory explanation of the immense output of energy of the sun and stars. The repercussions of this development on terrestrial physical science have been very great, and no physicist doubts that we are on the eve of a major advance which may surpass in practical importance the work on the external structure of the atom referred to earlier in this article.

Again it is gratifying to be able to record that the Canadian Observatories, through their work on the masses of stars (derived from spectroscopic binary orbits) and through studies of stellar temperatures and absolute luminosities, have been able to provide data of a kind which is indispensable to these investigations.

Another new development which is likely eventually to have an important influence on terrestrial physics is the enormous velocities of recession of the external galaxies.[9] The velocities of these objects have been shown to increase linearly with distance, and the most distant of them exhibit velocities of the order of 30,000 miles per second. The Dominion Astrophysical Observatory has been able to make a useful contribution to this work by the investigation of the rotational motion of our own galaxy. A knowledge of the motion of our solar system due to galactic rotation[10] makes possible a clarification of the otherwise contradictory data on the velocities of some of the nearer spirals and so permits the extension of the linear relation to small velocities of recession.

While so far no completely satisfactory explanation of the astonishingly high velocities of the spiral nebulae has been found, a great amount of scientific energy has been directed toward the solution of the problem, and, when the solution comes, it may confidently be predicted that it will contribute toward the advancement of terrestrial physics.

Conclusion

In the foregoing article an attempt has been made to show that astronomical research has played an indispensable part in the progress of physical science, and that many of the most valuable assets of modern life have had their origin in astronomical discoveries. On its past record astronomy may justly claim consideration as one of the most useful of the sciences. For the future, its justification lies in its ability to fill in the gaps of terrestrial physics and to provide such vital information concerning the nature of matter as only observations of the stars and other heavenly bodies can give. The argument for the support of astronomy is the argument for the support of the organism of science as a whole, an organism which can only function efficiently if all its parts are maintained in a vigorous condition.

As for the expenditures involved, the most superficial study of the relation between science and industry will show that there never has been a type of investment made by human beings which has yielded such high returns as the money invested in scientific research. To support this statement it is only necessary to quote a few examples of major industries whose origin is to be found in scientific discoveries. Some of the most obvious include the electrical power industry, the telephone and telegraph industries, the wireless industry, the motion picture industry, the chemical and metallurgical industries, the dye stuff industry, a large part of the modern transportation industry and the science of engineering in all its phases. These examples make it

[8] A very readable account of this work is given by Gamow: *The Birth and Death of the Sun*, Viking Press, New York.
[9] See *The Realm of the Nebulae*, by Hubble, Yale University Press, New Haven.
[10] The velocity of our solar system due to the rotation of the galaxy is 200 miles per second. This velocity would, of course, have to be taken into account in studying the motion of an external system.

clear that the ability of a modern state to support its population is completely dependent upon the scientific work of past years. It is equally certain that the material progress of to-morrow will be dependent on the science of to-day, and it is fitting that a country like Canada, whose industrial and agricultural advancement has made her a major beneficiary of the science of the past, should assume an appropriate share of the financial burden of the scientific research of the present day, not only in the field of astronomy but in that of the other sciences.

Actually, the term "burden" is scarcely appropriate as used in this connection since up to the present no country in the world has made expenditures on science on a scale to put any serious strain on the national economy. The benefits accruing from the science of the past have been obtained as a result of such modest outlays as to have little significance as a fraction of national income. No doubt this will continue to be the case for some time to come. The problems of the future, however, whether in industry, agriculture, public health or human relationships, are likely to require for their solution a far greater concentration of scientific effort than anything that has been known in the past. No doubt the law of diminishing returns would eventually apply to expenditures on science as it does in other fields, but it will be a long time before that point is reached, and, in the meantime, any forward-looking modern state which is prepared to place scientific research in the forefront of its political programme is likely to find such a programme profitable, both from the point of view of material prosperity and of national prestige.

The Great Nebula in Orion. This beautiful photograph shows a cloud of interstellar matter lighted up by some bright stars. This material in the spaces between the stars is composed of gas and fine dust. It is usually so thinly distributed as to be invisible, but its presence can be detected with the aid of the spectrograph. The study of such material would not appear to have much practical value, but actually it has added considerably to our knowledge of atoms and molecules at low temperatures. Fig. 5 Photograph by J. S. Plaskett at the Dominion Astrophysical Observatory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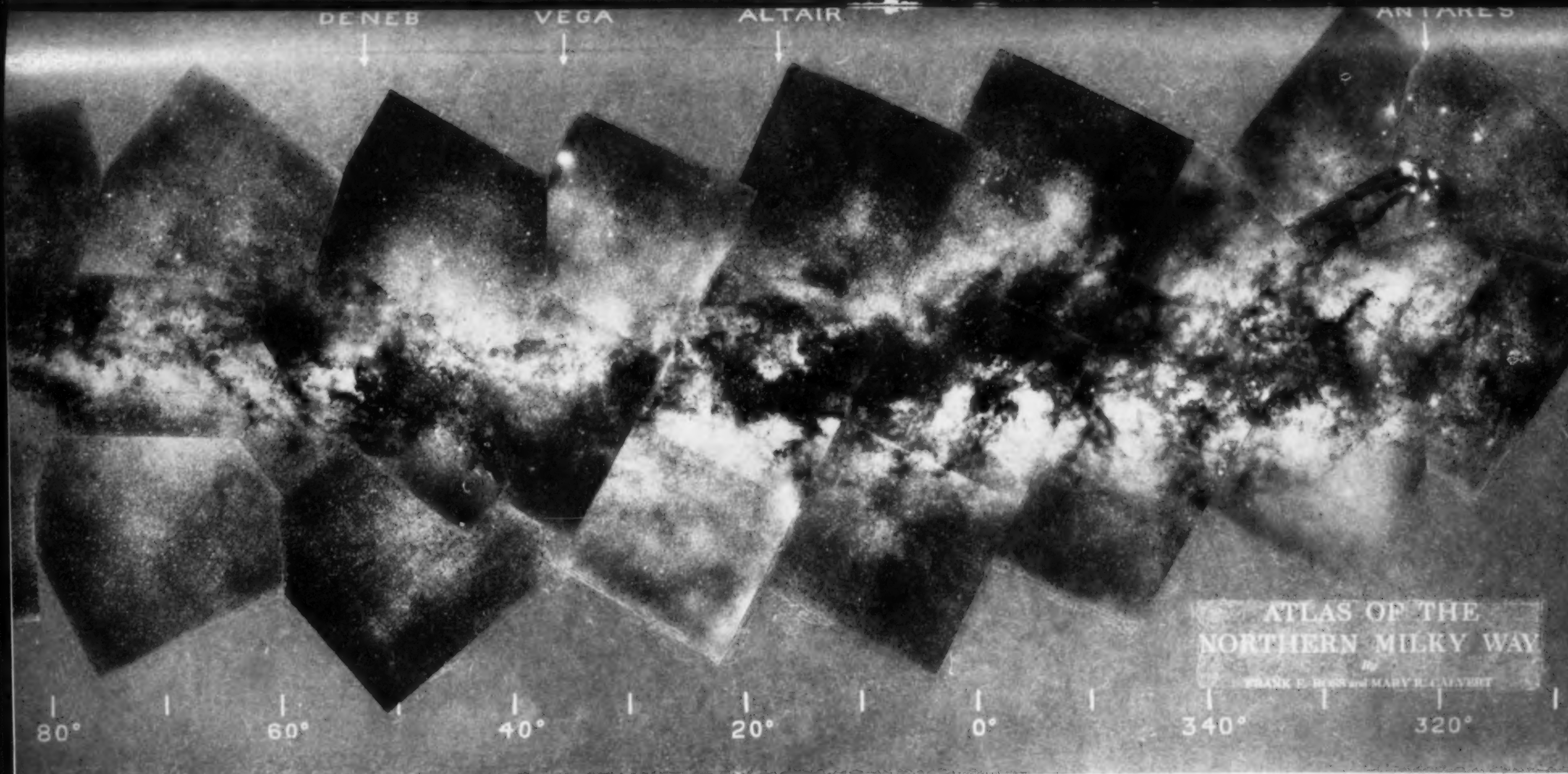

At top: Outside of a galaxy, looking in. A galaxy such as the one shown here is a vast assemblage of many millions of stars in a state of rotation somewhat resembling a spiral vortex in a fluid. Note the dark band of obscuring material in the plane of rotation. Fig. 6 Mount Wilson Observatory photograph

Above: Inside our own galaxy, looking out. A composite photograph of our own Milky Way, which is, in reality, an aggregation of stars like the one in figure 6 above. Note how the dark band of obscuring matter looks from the inside. The use of the spectrograph makes each one of this great multitude of stars (which range in temperature from 2,000° F. to 200,000° F., and in size from 8,000 miles to 400,000,000 miles in diameter) a potential source of new physical information. Since the fundamental nature of matter is the same in the stars as on earth, most astronomical discoveries eventually find useful practical applications.

Fig. 7 Photograph by Ross and Calvert, Yerkes Observatory

His Majesty's Canadian Ship CONESTOGA

by SUB-LIEUT. FLORENCE WHYARD, W.R.C.N.S.

"ALMIGHTY GOD, in Whom all wisdom dwelleth, we pray Thee to guide and protect the training establishments and ships of our Navy. Bless all their members, past and present; all who bear rule or teach therein, with all who learn or serve. We thank Thee for the benefits of our common life; for Thy gifts of friendship, happiness and knowledge. And we pray that we, together with all those who have passed through such training, may so serve our generation on earth as to be fitted for Thy eternal service in heaven; through Jesus Christ our Lord, Amen."

The naval chaplain closed his prayer book. The bugler sounded the general salute. A new white ensign was raised by the halyardmen, and another ship had been commissioned in the service of the Royal Canadian Navy. But this ship did not slip down the

At top:—Captain Isherwood inspects Conestoga's *Wrens with Lieutenant Florance on the day of the commissioning.*

Top left:—A trim looking crew—in spite of a mixture of uniforms

Bottom left:—Captain Dorothy Isherwood salutes the colours of the Galt Boy Scout Bugle Band as it leads the march past of Wren ship's company during the commissioning ceremonies

ways—no crowds of shipyard workers cheered her on.

This training ship was different. That day in June, 1943, she became the first and only ship of the Royal Canadian Navy captained by a woman, manned by Wrens. Never to hear the firing of guns nor the roaring of angry seas, H.M.C.S. *Conestoga* was a stone frigate, a land establishment for the purpose of training members of the Women's Royal Canadian Naval Service. Unique not only in Canada, but throughout the British Empire, the Wren ship was on active service from October, 1942, until April, 1945, and every new entry in the W.R.C.N.S. trained on board her. This is her story.

Her beginnings coincided with the beginnings of the women's section of the Royal Canadian Navy, and almost as soon as the first applicants for naval service were being interviewed by the three British Wren officers who came out to Canada to set up the W.R.C.N.S., naval officials were inspecting suitable sites for a training establishment which could accommodate several hundred Wrens. The offer of the Ontario Government to turn over the Girls' School at Galt for the Navy's use was accepted, and September and October, 1942, saw preparations being made for the incoming Wrens at Galt while the first class took its training at Kingsmill House, Ottawa.

In those first hectic days, when women who had been at civilian jobs only a few short weeks before were called upon to assume the responsibilities of leadership in the Navy, the British officers (Joan Carpenter, Dorothy Isherwood, Doris Taylor, Betty Samuel, Elizabeth Sturdee) kept high the standards of the new branch of the service, and so quickly did the Canadian Wrens assimilate the knowledge of naval duties and customs, so easily did they adapt themselves to ship's routine, that within a few months the entire company on board the training establishment consisted of Wren officers and ratings.

Since that time, the only male personnel on board have been the stokers and a shipwright and plumber with occasional maintenance men. Wrens assumed all the jobs normally undertaken by men in shore establishments. The first woman medical officer arrived to take charge of Sick Bay; the duties of the accountant officer were undertaken by a Wren paymaster lieutenant when the paymaster lieutenant, R.C.N.V.R., went to sea in December, 1943; Wrens took over the victualling, naval store and kitting jobs; captain's writers, pay writers, motor transport drivers, cooks, stewards, regulators—all were Wrens.

Training was its purpose, but the Galt establishment required a ship's company to run it, and those Wrens served just as Wrens in any other naval base. The reputation of H.M.C.S. *Conestoga* as a ship depended on them. Some of them spent two-thirds of their service in the W.R.C.N.S. at Galt, and its closing was a sad time for most of them.

For the first eight months of its existence, Galt's training establishment was known as H.M.C.S. *Bytown*, Division 11, and was under the administrative control of Naval

Commander Isabel Macneill, O.B.E., Captain of the only Wren ship in the R.C.N.— H.M.C.S. Conestoga

Top right:—Wren blocks at Galt, as elsewhere, were named after British admirals.

Top left:—Finding one's own luggage was the first step in getting settled.

Centre:—View of Conestoga which never failed to thrill new Wrens.

Right:—First glimpse of their new life in the Navy was the railroad station at Galt, and the "Duty Boat" waiting for them.

Service Headquarters at Ottawa. But in June, 1943, it became more than just a training establishment. At the suggestion of Captain Dorothy Isherwood, then Director of the Canadian Wrens, naval authorities considered the radical proposal that the establishment should be commissioned as a training ship in the Royal Canadian Navy!

The Deputy Judge Advocate of the Fleet pointed out, when queried as to the propriety of this move, that "as W.R.C.N.S. personnel are not an Auxiliary Service but are just as much part of the naval forces of Canada as the R.C.N.V.R., and as the officers hold His Majesty's Commission, there appears to be no technical reason why such officers should not take command of His Majesty's Ships". Isabel J. Macneill, then First Officer, became officer in charge in March, 1943.

But if the Galt establishment were to be commissioned, it would need a name. Suggestions came forth from the official naval section which selects names for H.M. Ships, but the choice of the W.R.C.N.S. and the townspeople of Galt won out—the ship would be commissioned H.M.C.S. *Conestoga*, as a link between Canada's courageous present and her pioneer past.

The Conestoga tribe of Indians, after whom the Conestoga waggon was named, was well known to the Pennsylvania Dutch settlers of Mennonite persuasion who had come north to settle in the Galt district, and the members of one pioneer party had called a stream they came upon in that vicinity the "Conestoga" because it reminded them of the Conestoga River in Pennsylvania. Thus, a hundred years after their great-grand-

Top to bottom:—

Two Waves came on board to help celebrate the Wren's first birthday in August, 1943.

The Chief of Naval Staff, Vice-Admiral G. C. Jones, with Lieutenant Phoebe Morris, inspects the guard of honour.

"Rounds" leaves Beatty block during the Admiral's inspection of the ship.

The Hon. Angus L. Macdonald, Minister of National Defence for Naval Services, inspects a company of Wrens with Lieutenant Helen Ockenden.

The Princess is piped on board by six specially selected members of Conestoga's ship's company.

mothers, Canadian women were again to follow the "Conestoga Trail" to hard new worlds, where there would be difficult new tasks, and little glory.

New entry training included plenty of hard work, and the probie Wrens were always ready for bed at the end of the day. "Wakey-Wakey" sounded at 0630 on board the good ship *Conestoga*. Breakfast began at 0700, and the duty watch mustered for working parties or physical training half an hour later. Very few of the girls who arrived at Galt from every part of Canada to become Wrens had ever scrubbed decks, shovelled snow, pushed garbage waggons, weeded lawns or cleaned washrooms at 7.30 in the morning. But there was little "nattering" about it; rules were the same for every one; each probie Wren served her turn at these disagreeable tasks. Volunteers all, they knew that they were undergoing a one-month probationary period, during which the Naval Service determined whether or not they would make good Wrens. It seemed the most important thing in the world to come through that trial period with flying colours!

The entire ship's company mustered for divisions every day at 0845, and then it was that new Wrens got their first taste of traditional naval ceremony. Having fallen in on the parade ground according to their divisions, "tallest on the right, shortest on the left", with shoes polished to perfection, hair rolled off the collar, ties knotted correctly, uniforms spick and span, the Wrens were mustered by their divisional leading hands, inspected by their divisional officers, and then came their Commanding Officer's beautiful voice in some of the age-old naval prayers.

"O Eternal Lord God, Who alone spreadest out the heavens and rulest the raging of the sea; be pleased to receive into Thy protection those who in this time of war go down to the sea in ships, and occupy their business in great waters. Preserve them both in body and soul; prosper their labours with good success; in all times of danger be their defence; and bring them to the haven where they would be, through Jesus Christ our Lord. Amen."

It was from an inspirational moment such as that, outdoors in the beauty of Canadian summer, green hills and fields around them, blue sky above and the Navy in their hearts, that the Wrens went about their daily routine at *Conestoga*.

There was a wild rush from the parade ground to change into shorts for drilling or working in the garden; or to the auditorium for lectures, or to the galley to wipe dishes. Every minute of the day was filled. Between

Above:—The beauty parlour—part of barracks' routine for every Wren.

Left, top to bottom:—

A new Wren is interviewed by the divisional officer.

Kitting stores, where the probie is completely outfitted.

Supply assistants check the sizes of summer and winter suits.

The new Wren is supplied with two hats—the sailor beret with removable white cover for summer wear, and the "tiddley" tricorne for off-duty and special parade occasions (top).

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Above:—Every probie Wren is interviewed by the medical officer and inspected by the nursing sister and sick berth attendant in Sick Bay (top).

Right, top to bottom:—

Dinner in the Conestoga mess hall is cafeteria style—and good.

Wrens relax in one of the comfortable fo'c'sles.

Master-at-arms Phyllis Sanderson and Angus, the Great Dane

Favourite choice of summer working parties was the three-acre garden at Galt.

Leading Wren Mary Lee Pyke (rseas) in

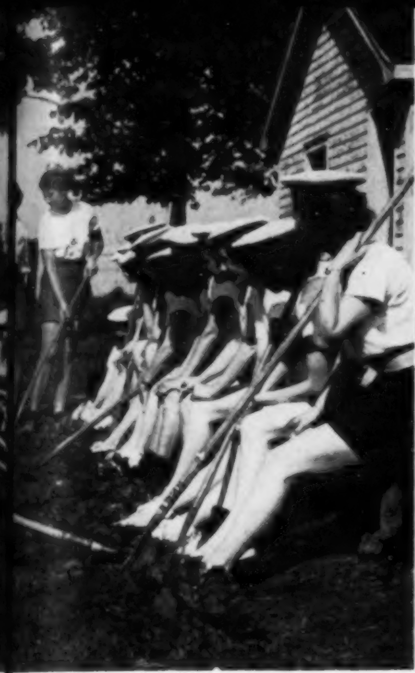
working parties, lectures and drill the Wrens had periods for "Secure" or "Stand Easy" when they could relax with letters from home, or drop over to the canteen for a cool drink. There was always "Tea Boat" in the afternoon and there were study periods, which, in summer, lured the Wrens outdoors again to sit on the lawns and quiz one another on "Naval Traditions", or the essentials of Naval Law; how to send naval signals, who was the first Canadian Admiral, what tonnage a battleship should have, and what is the calibre of the largest naval guns.

Dinner and supper were downed with speed and gusto in the bright mess hall, and every new Wren seemed to gain weight despite the activity of her new life. In the evenings there were ball games, music appreciation groups, movies, handicraft instruction, or time spent relaxing in the comfortably furnished fo'c'sle. But at 2200, when the call came to "Pipe Down", all Wrens were back in their cabins with the double deckers, cupboards and chests of drawers, and by 2230, when "Darken Ship" was sounded, eyes drooped into sleep the minute tired heads touched the pillows.

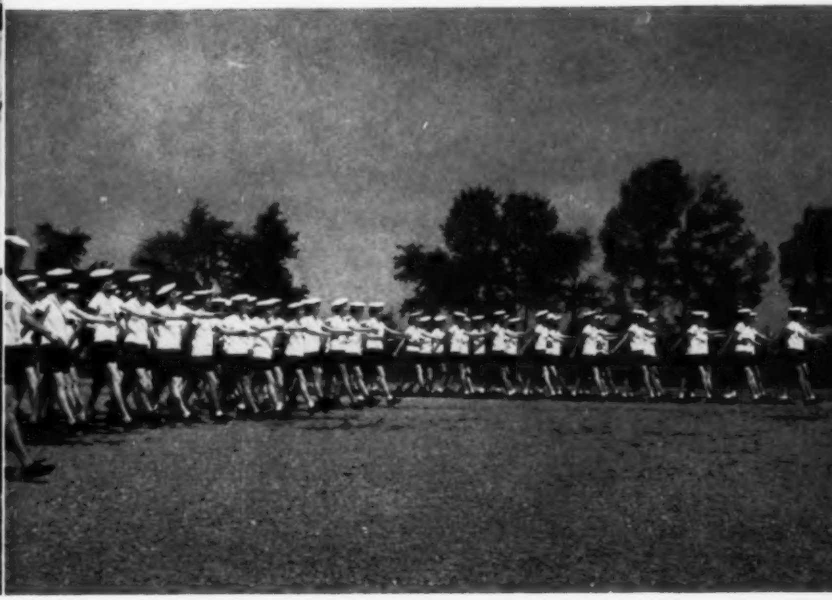
After they had been kitted with their new uniforms, and learned how to salute, and conduct themselves as Wrens should, the new entries were allowed to "Go Ashore" certain afternoons and evenings during the week. At first there were people who felt that was carrying things just a bit too far—going ashore in "Liberty Boats" from brick buildings in Western Ontario! But the training and discipline the Wrens received from weeks of following naval routine, almost as if they were serving at sea, soon had results, and their smart, naval appearance affected the citizens of Galt so that soon they too were referring to the five buildings on the hill outside the city as "The Ship".

They came in regular drafts, 6,000 of them all told, arriving as bewildered civilians, going through their barracks' routine, getting their hair cut to service standards without regard for glamour, learning to call their officers "Ma'am" and never forgetting to salute the quarterdeck; passing weekly examinations on naval subjects, drilling till response to an order was automatic, and finally being paraded by their divisional officer to their "Rating-up" ceremony, when they were advanced to the rating of "Wren" and ready to be drafted out to their new jobs with the Navy.

The permanent ship's company became accustomed to seeing newly-rated Wrens come running down the path between Wren



ke [...]seas) instructs embryo gardeners.



A smart looking squad developed by hours of drilling.

blocks, shouting "I'm drafted! I'm drafted!" to all they met and rushing to their cabins to pack the suddenly amazing amount of stuff which seemed to have accumulated mysteriously from nowhere. Then the reaction set in, and just as customary was the sight of some woebegone Wren sitting on a pile of kit bags and luggage, unhappily facing the prospect of saying "good-bye" to new and very dear friends, whose paths might take them to the other side of the continent.

There were never dull days at *Conestoga*. Incoming and outgoing drafts always provided excitement; distinguished visitors came on board frequently; there were parades and inspections galore; servicemen from nearby training centres were guests at dances and picnics; the Beaver Club in Galt always had its quota of Wrens on hand. The "Navy Show" came to Galt; the W.R.C.N.S. birthdays were celebrated with giant corn-roasts and sports days; excursions to places of interest in the vicinity were planned, and bicycling Wrens toured the countryside on fine summer days. And here a tribute to the townsfolk of Galt and Preston who opened their city and their homes to the Wrens.

In October, 1943, a group of Wrens paid the first of a series of visits to H.M.C.S. *Pathfinder* for a cruise on board that training ship out of Hamilton. On their return to Galt, they were voluble and enthusiastic about the 40-mile cruise during which they took their turns at swabbing decks, polishing brass, port and starboard lookouts and tricks at the wheel. Through the kindness of the Commanding Officer, H.M.C.S. *Star*, this custom was continued the following summer and many probie Wrens chalked up "sea-time" during their stay at Galt.

Royalty came on board the training ship on two occasions when Princess Alice, Honorary Commandant of the Women's Royal Canadian Naval Service, visited H.M.C.S. *Conestoga*. Her Royal Highness inspected the ship in December, 1942, and again paid a farewell visit in January, 1945, when she was piped on board, inspected a royal guard of 96 Wrens, and made thorough commodore's rounds.

An impressive sharing in naval tradition was the lot of Wrens who spent Christmas and New Year's on board the training ship. Ship's company dances and candlelight services led up to the day itself when the youngest Probationary Wren was appointed Captain and gave the order for the Christmas Garland to be hoisted up the mast.

A drill squad, with its divisional leading hand rounds the curve of the tarmac at Galt.

Dinner was served the ratings by the Wren officers, proudly wearing their cook's caps and aprons, and presents were distributed to one and all by Santa Claus (alias one of the stokers). Singing and laughter filled the rooms. In the evening, the Commanding Officer visited the Wrens in their own fo'c'sles and read the Christmas stories they all loved. There was carol singing, and mail from home, mysterious parcels everywhere and gorged tummies on Christmas Day. No one was homesick there.

New Year's Eve brought fun too, when the most junior officer on board rang in the New Year on the ship's bell with sixteen bells, eight for the old year, eight for the new, at midnight, after a hilarious ship's concert. Punch was served and when the Commanding Officer proposed the toast to the New Year, every member of the ship's company responded heartily.

A highlight in herself was Master-at-Arms Phyllis Sanderson who was known to nearly every Wren as "Sandy". Her wonderful voice, with its power to instil smartness and

By the second summer, there were Wren drummers to lead the drillers.

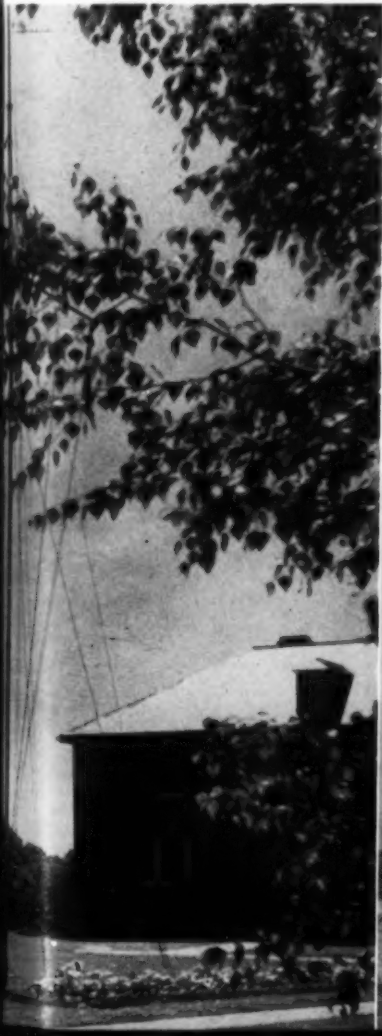
Sunday morning divisions, the C.O. takes the salute.

precision into any group she was training, transformed girls with debutante slouches into keen looking Wrens. Her twinkling eyes, Scottish accent, and very "pusser" attitude towards everything naval, became part of the atmosphere at *Conestoga* until she went overseas in December, 1944, as the first Wren M.A.A. in H.M.C.S. *Niobe.*

All new entries were "Matilda" to "Sandy", and Wrens would hear her shouting "On the double! Matilda!" from some window in the main block to a hapless probie who had thought she was walking across the parade ground unseen.

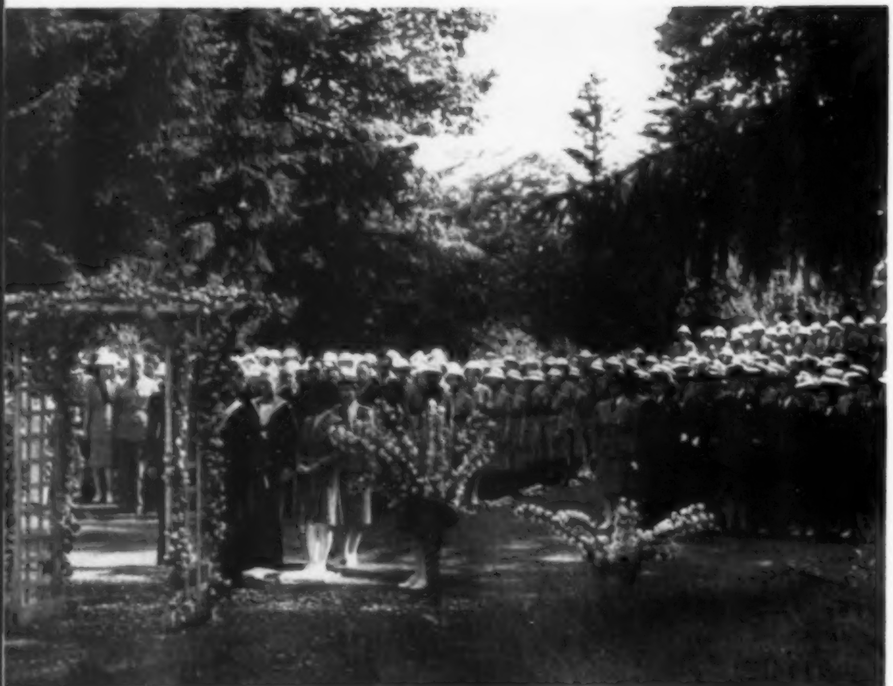
Conestoga trained not only Canadian Wrens, but many from the W.R.N.S. as well, who were serving in Washington and New York and had enlisted in the United States. For many of them, it was their first glimpse of Canada, and most of them seemed to manage to return to their duties via Niagara Falls!

Every ship has its mascots, and *Conestoga* was no exception. First and always there was Trilby, little copper-coloured dachshund



Wren drummers beside the quarterdeck

Wren daily routine—drill and more drill



The first Wren wedding on board—in the gardens at Jellicoe division

pet of the Commanding Officer, who pattered around at Commander Macneill's feet throughout the day's inspections and faithfully attended all her lectures. There was Bytown, a playful black and white spaniel; there was Angus, a pontifical Great Dane donated to the ship by a citizen of Galt; there was Drummer, a setter who loved to march with the Wren drummers; there was Leading Wren Skipper, a Cocker spaniel pet of the Paymaster, and of course a ship's cat, Jack Dusty.

Sometimes it was difficult to stand rigidly at attention during morning divisions when Skipper and Bytown played tag around little Trilby, in and out among the Wrens, but usually the pets were good shipmates and sat quietly by until the ceremony was over.

Before she left Vancouver to conduct the last draft of Western Wrens to Galt, (27 months after she had made the trip herself as a probie Wren) Petty Officer Margaret Stevens put it this way: "We're all more Navy than the Navy at *Conestoga*. And you just can't let down because you represent something to that probie Wren who's just come in . . . I'll hate to see the ensign lowered for the last time. I've loved it there, the work and the place and everything about it. There can never be another *Conestoga* for us anywhere."

What made *Conestoga* like that ? Any one can assemble a group of girls, house them, clothe them, feed them and subject them to discipline. But how to make them think as Wrens ? How to teach them pride in their Service and in their uniforms ? Obviously, it takes an exceptional personality to meet the challenge of hundreds of new entries arriving regularly, few with naval backgrounds or training, but all with something in common which led them to volunteer to serve for the duration wherever their duties with the Navy might take them. *Conestoga's* Captain had that personality.

Commander Isabel J. Macneill, O.B.E., born in Halifax, the daughter of a Dalhousie University professor, had been doing voluntary work for the Navy there for the first two years of war before she enlisted in the first class of Canadian Wrens in August, 1942. Reluctant to give up her voluntary work, she felt that the manpower situation had reached a crisis in Canada, and the time had come when single women without dependants had to join active services, pre-

pared to do anything, go anywhere they could be of use.

By one of those curious twists of fate, joining the Navy took her away from the sea, away from the ships and the sailors she admired so much. But it took her to a new ship, made her the first woman captain of one of His Majesty's Canadian Ships, gave her influence over the lives of six thousand other Canadian women.

Inspiringly naval at divisions, or evening quarters, the C.O. could be a sympathetic woman, too, and many a Wren who received bad news while at Galt found an understanding counsellor and friend in her. She was the spirit of gaiety at Wren weddings, when she acted as "family" for the Wren and gave the bride away, and she was always a good sport when the officers set out to entertain the ratings.

The officers worked at gardening in the summer months, and the story is well known of the probie who wandered up to a figure in slacks and sports shirt, working on a flower bed one evening, to ask "Are ya diggin' or plantin'?" Said the gardener in a muffled voice, "Diggin'". Whereupon the new entry said "I'd like to try that, do you think they might let me, sometime?" Assured that "they" might, she went on chatting about her new life and her impressions of *Conestoga* for some minutes. It was not until the next morning at divisions that she recognized her gardening friend—it was the Captain!

It was the same Captain who watched the last class of Wrens at *Conestoga* go through their rating-up ceremony of graduation on the 4th of March, 1945; bade them farewell, sent them out to their new duties with the warning that they must not expect excitement or adventure, but must take dull routine jobs as their fair share of the work which must be done behind the scenes, to keep Canadian ships and men in the fighting zones.

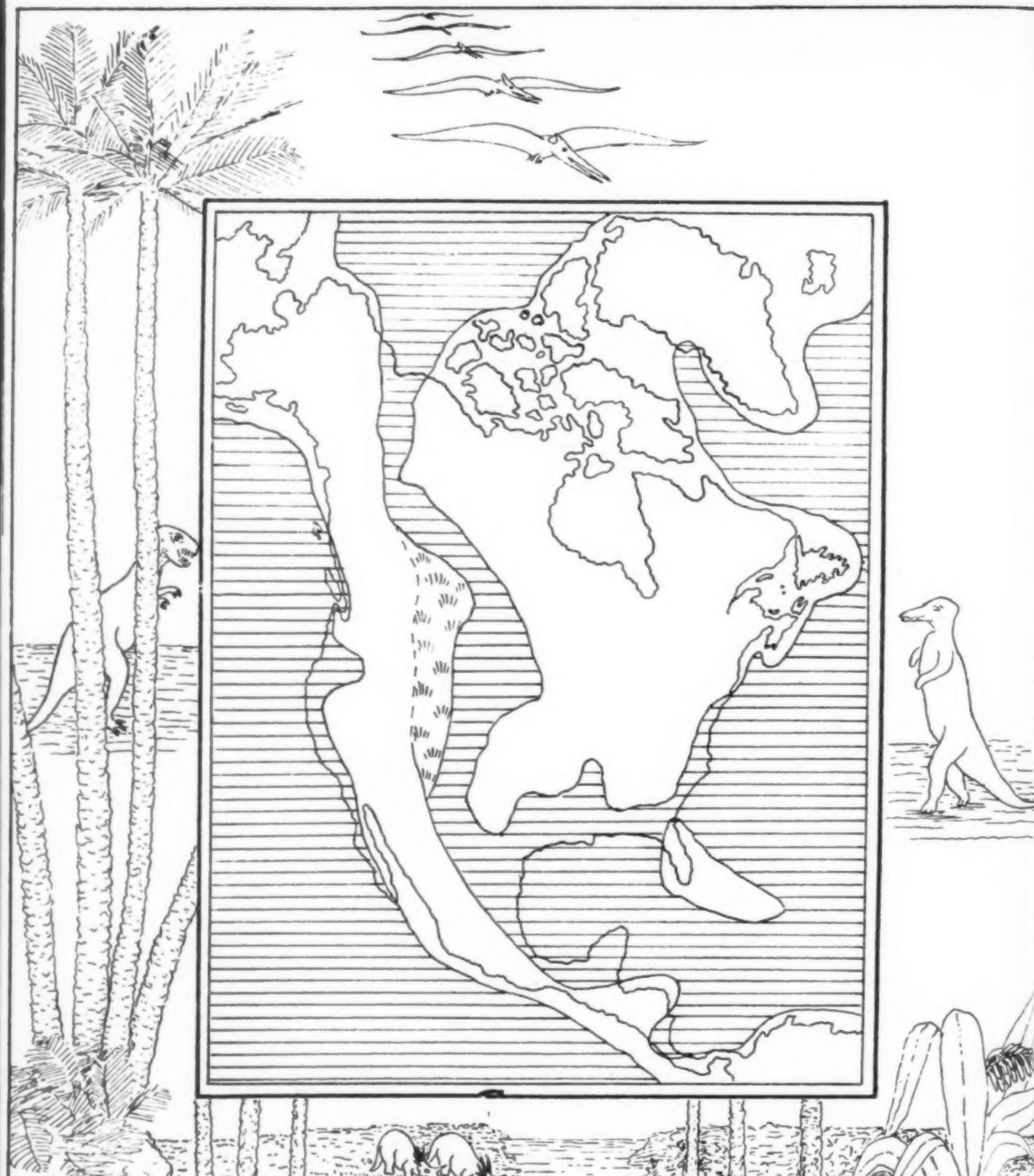
Then the permanent ship's company began to leave—supply assistants, writers, tailoresses, hairdressers, postal clerks, the cooks, switchboard operators, sick berth attendants, regulating Wrens, until only a skeleton staff remained for the paying-off.

All the tiresome, anticlimatic business came then—shipping away supplies, checking files and sending them to headquarters; returning uniforms, writing off the hundred and one items needed to manage such a large establishment, "home" to nearly 600 Wrens at one time.

By the end of March, all was finished and the final paying-off of ship's company took place. For the last time, the white ensign was lowered and as H.M.C.S. *Conestoga* retired from active service, a little group of women in navy uniforms saluted with pride and sadness.

She had done her job and done it well. What ship could ask a better epitaph? In the hearts of Canadian Wrens throughout Canada, in New York and Newfoundland, Greenoch and Glasgow, London or Londonderry, there will never be another ship like *Conestoga*.

A new white ensign is raised at the commissioning of H.M.C.S. Conestoga.



North America in late Cretaceous time. After Matthew. Dinosaurs inhabited the deltas which were being built up along the western edge of the inland sea.

Courtesy American Museum of Natural History

Canadian Dinosaurs

Their Place in Nature and Conditions Under Which They Lived.

by C. M. STERNBERG

INTRODUCTION

DINOSAURS lived during the "Age of Reptiles" and became extinct about sixty million years ago. To obtain some idea of their place in nature, one must first glance at the past history of the earth and its ancient inhabitants.

Palaeontology deals with the history of life and its time as measured in geological periods, in millions of years rather than centuries as civilization is measured. We study the history of the species instead of the individual or the dynasty. The six or eight thousand years of civilization is as yesterday compared to the time that animal life has been on the earth.

During the past geological ages a great variety of animals flourished during their time, and then became extinct—in many instances leaving no descendants. In other cases, these ancient animals evolved into highly specialized forms, or certain primitive forms may have persisted to the present with little change. Among the mammals, the egg-laying duck-billed platypus and the marsupials are examples of the persistence of primitive types.

We often say, "What strange animals lived in prehistoric time", but we do not think of such specialized mammals as the bat, the giraffe, the elephant or the whale as strange because we are familiar with them. These and many other forms were evolved to meet special living conditions. Few extinct forms are more ungainly-looking than the giraffe.

One must not think of extinct animals as merely prehistoric and imagine that they all lived together. It is hard to realize that one geological period, with its special types of plants and animals, covered millions of years and that the flora and fauna were as distinct from those of another period as each was from that of the present.

We would know nothing about these ancient animals but for the fact that many of them left their bones, shells, tracks or impressions entombed in the sand, mud, lime-ooze, etc., which covered them and later became rock. By the study of these fossil remains we are able to get a bird's-eye view of the past history of life on the earth and trace the gradual evolution, through countless generations, from simple to highly specialized forms. Most of us have some idea of the evolution of the horse, the camel and the elephant, but many do not realize that dinosaurs and other reptiles evolved from simple to highly specialized forms before they became extinct.

GEOLOGICAL TIME TABLE

ERA	CHARACTERISTIC LIFE	PERIOD	BEGAN YEARS AGO
Cenozoic	Age of Man	Quarternary	1,000,000
	Age of Mammals Development of modern mammals and birds, and flowering plants	Tertiary	60,000,000
Mesozoic	Age of Reptiles Rise of reptiles and beginning of modern plants	Cretaceous	
		Jurassic	
		Triassic	190,000,000
Palaeozoic	Age of Amphibians Giant mosses and rushes	Permian	
	Development of great coal deposits	Carboniferous	280,000,000
	Age of Fishes	Devonian	
		Silurian	350,000,000
	Age of Invertebrates		

*Published by permission of the Director of Mines and Geology Branch, Department of Mines and Resources.

Right: Red Deer River has cut a great trough, 500 feet deep, through dinosaur burial grounds west of Munson, Alberta. Centre:—The ancient delta deposits are composed of shale (dark bands) and sandstone (light coloured beds). Cross bedding is common.

The discovery of fossils may enable the geologist to determine the exact age of the strata and help him to work out oil structures, etc. The study of fossils also helps us to settle many problems of the distribution of living forms and to determine at what geological period the continents, which are now separated, were united or vice versa.

The Geological Survey and National Museum of Canada possess an excellent collection of Upper Cretaceous dinosaurs, but due to lack of space many of these have not yet been placed on exhibition.

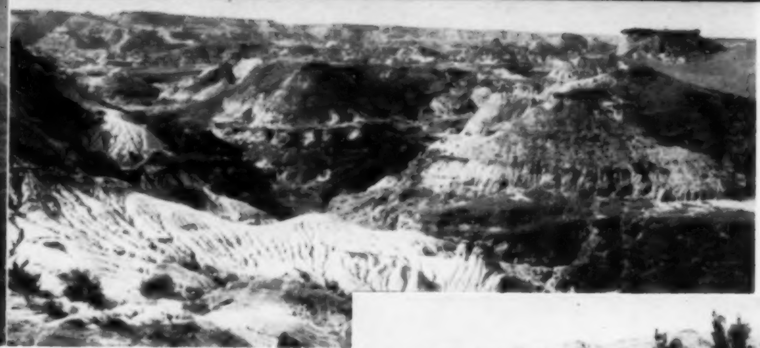
Ancient Conditions

The earth's crust has always been constantly changing but the change is usually so slow that it is not noticed. Frost, rain, waves and wind are continually wearing down the highland. Sand, silt and mud are carried by rivers or wind and dumped into the seas, lakes or lowlands. Unequal pressure on the earth's crust causes certain areas to be depressed below the level of the sea while other areas are elevated. This may be a gradual depression or elevation of the continent or a sharp folding of the crust forming great mountain chains. Many sections of North America have been depressed and re-elevated several times during the past geological ages.

If one could be transported to late Cretaceous time by some mysterious time machine, North America would seem very different from the present. A great depression through the central part of the continent was occupied by the shallow Cretaceous Sea which extended from the Gulf of Mexico to the Arctic Ocean and completely separated the eastern and western parts of the continent. The Rocky Mountains had not yet been formed but their upward thrust was begun before the close of the Cretaceous, and the end of the period marked the draining of the inland sea. During this time Asia must have been connected with the western part of North America to allow free migration between the continents as similar dinosaurs are found on both.

Rivers running from the higher lands, farther west, carried millions of tons of sand and clay into the western edge of the Cretaceous Sea, thus building up great deltas hundreds of feet in thickness and thousands of square miles in extent. On these deltas, in the swamps, along the flood-plains of the rivers and on the uplands farther west lived a great variety of reptiles, particularly dinosaurs. Evidence points to a dense growth of both land and water plants, and the presence of palms, figs and other plants of similar habitat indicates that the climate was sub-tropical. We must not think that all the forms found buried in these strata lived together. The building up of these deltas must have taken many, many thousands of years, and the forms that lived in the swamps or on the highland a hundred or more miles from the shore line were all buried in the deltas. The fact that the big swamp-dwelling forms are more numerous in our collections does not prove that in actual life they were more abundant than the upland types but merely that a greater proportion of them were buried in the deltas before the flesh was devoured or the bones destroyed by exposure to the air. Of the forms that lived on the upland only the more durable parts of the skeleton would usually withstand transportation. The odd carcass, however, might be brought down by a flood.

Usually an upland habitat is not so favourable for the preservation of fossils, for even if the skeleton is covered by wind-blown sand or other deposits these strata would be



Left:—General view of badlands in Sand Creek area, about 120 miles east of Calgary. Many fine dinosaur specimens have been collected from this region.

the first swept away by erosion during the periods of uplift. One notable exception to this rule is found in the Gobi Desert of Mongolia where dinosaurian remains are found in strata which were deposited under conditions somewhat similar to those existing there to-day. The presence of dinosaur eggs and many juveniles in these desert deposits, and the general absence of both eggs and juveniles in swamp and delta deposits suggest that eggs were laid and the young reared on the upland and that only more or less mature dinosaurs inhabited the swamps and bayous. Many modern animals are known to travel hundreds of miles to deposit their eggs or rear their young in some favoured locality. Among reptiles the sea-turtles are a good example of this habit.

The Age of Reptiles

Certain geological periods have been grouped and named for the dominant animals of the time. The shortest was the "Age of Man" during which man sprang from an already highly developed ancestor and continued to develop and has since ruled the earth. This age corresponds to the Pleistocene and Recent periods of perhaps not more than a million years. The "Age of Man" was preceded by the "Age of Mammals" which lasted about fifty-nine million years. During this time our modern mammals and birds developed. Preceding the "Age of Mammals" was the much longer "Age of Reptiles" which corresponds to the Triassic, Jurassic and Cretaceous periods. The modern estimate of sixty million years since the close of Cretaceous time is probably

Top to bottom:
Fossil hunters' camp on Sand Creek. Badlands in the background

Natural erosion of rain, frost and wind carves the badlands into fantastic shapes. The fossil hunter searches for some exposed bone which might lead to a complete skeleton.

Thick sandstone beds are fluted by thousands of little rivulets. Beds of clay-ironstone are shown as thin brown bands.

much more accurate than the shorter estimate accepted thirty years ago.

During the "Age of Reptiles" fishes and amphibians were still abundant but reptiles ruled supreme. They were prolific and evolved into many highly specialized types. Birds and mammals were developing but mammals made little advance in comparison with reptiles. In the seas were found several orders of reptiles such as Ichthyosaurs (fish lizard), Plesiosaurs (near lizard) marine crocodiles, etc. A great variety of flying reptiles, known as Pterodactyles (wing finger), occupied the air as do the birds and bats of to-day. Though swamp turtles and the modern type of crocodiles were common during the late Cretaceous, the dinosaurs definitely dominated the land from the swamps to desert highlands.

During the Cretaceous period the ancient flora of giant rushes, tree-ferns, cycads, Norfolk Island pine, etc., gave way to the modern flora, and by the close of the period, flowering plants and deciduous trees were well established. Reptiles of to-day are not very different from representatives of the same orders which lived during late Cretaceous time, but mammals and birds made their greatest advance since that time. We do not know what stimulated evolution of the reptiles during one age and the birds and mammals during another. The modern flora with more concentrated and nourishing food, the insect population and atmospheric conditions may have had considerable influence.

Dinosaurs were among the most interesting and spectacular of all ancient reptiles. The name "dinosaur" was derived from Greek and means "terrible lizard". It was proposed in 1842 by Prof. Owen, the eminent English palaeontologist, to cover an order of reptiles. In accepted classifications to-day dinosaurs are regarded as representing two distinct orders of the class Reptilia.

Early Discoveries

In the year 1800, Pliny Moody of South Hadley, Massachusetts, ploughed up a piece of flagstone on which was impressed a dinosaur track. Young Moody referred to this as the track of Noah's raven. In 1836, Prof. E. Hitchcock figured and described a number of fine dinosaur tracks which had been collected from the Connecticut valley. The tracks were mostly three-toed and had been made by small to moderate-sized, bipedal dinosaurs. Prof. Hitchcock described these as bird tracks. A number of years later it was realized that the tracks had been made not by birds but by dinosaurs. In fact, at the time the tracks were described, almost nothing was known about the structure of dinosaurs. The first discovery of dinosaurs in Canada was made by Dr. G. M. Dawson, in Upper Cretaceous rocks of southern Saskatchewan and Alberta, in 1874. From this small beginning the study of dinosaurs has gone steadily forward until now we know more than four hundred distinct species. Many of these are known from almost complete skeletons, and in some the impression of the integument is preserved.

Kinds of Dinosaurs

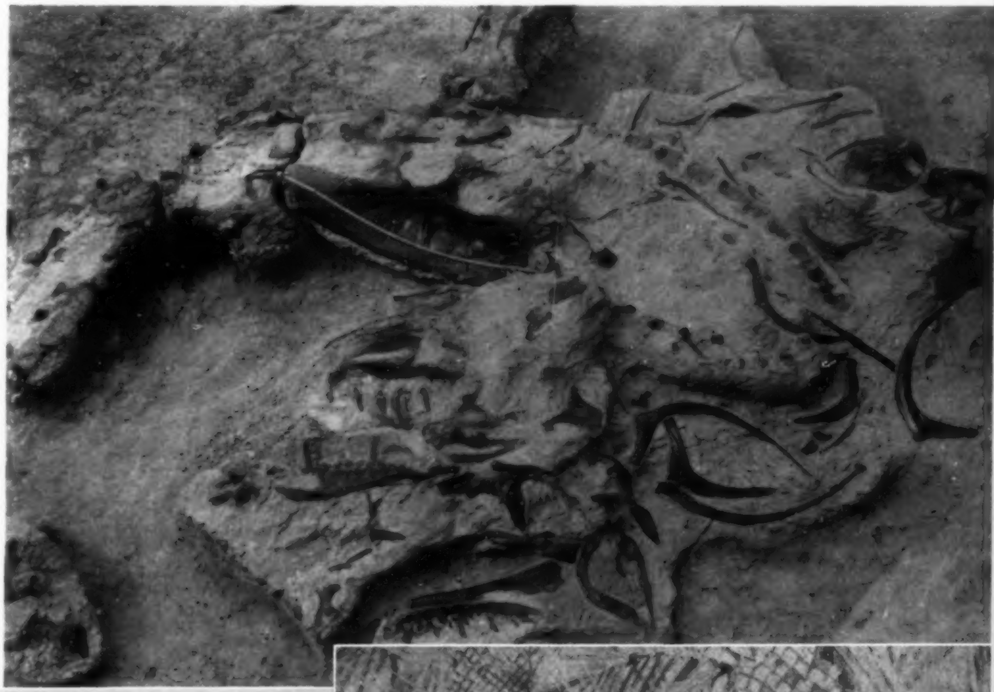
It is believed that the dinosaurs evolved from a small lizard-like reptile with comparatively long limbs, long tail, and five-toed feet. It is now generally thought that dinosaurs and birds developed from a common ancestor, and not that birds evolved from dinosaurs as some once believed. From this ancestral form there developed a great variety of dinosaurs ranging in size from less than two to more than one hundred feet in length. Though these last-mentioned were the largest land animals that ever existed, their bulk was not as great as some of the modern whales because much of their length was taken up by the very long neck and tail. All dinosaurs had four limbs though in some the front ones were very small. All the true carnivorous, and some of the herbivorous, dinosaurs were bipedal, at least in their later development, but many of the herbivores were habitually quadrupedal. Others probably rested on their fore feet while feeding, but when in a hurry assumed the bipedal pose. Some were light-limbed and swift while others were heavy, broad-backed, clumsy creatures. Some were protected by bony armour while in others the skin was very thin. Some had very small heads, some huge

heads surmounted by long, sharp horns, and others, powerful jaws filled with long, sharp teeth. The brain was of a primitive type and very small. In long-necked forms the head was small, but in forms with a very large head or powerful jaws, the law of mechanics made it imperative that the neck be short and well muscled.

The limbs of dinosaurs were so constructed as to give support to the body and carry it free of the ground at all times, as in birds and mammals, whereas in most reptiles the limbs are weak and the body rests on the ground except when the animal is in motion.

In most of the carnivorous forms the body was relatively short and compact and was balanced on the powerful hind limbs with the long, heavy tail serving as a counterbalance. The tail was rigid and could not have been curved over the back or wrapped around a tree as is the case with certain modern tree-dwelling lizards and mammals.

Right:—Disarticulated skeleton of large flesh-eating dinosaur (Gorgosaurus) in the rock in Sand Creek area. The teeth were lance-like, slightly recurved and suitable for grasping and tearing flesh.



ull of large carnivorous dinosaur (Gorgosaurus) mounted the National Museum of Canada. The lower jaw is nearly r feet long and was hinged at the back enabling him pen the mouth with a very wide gape, like a crocodile.

Restoration of small carnivorous dinosaur (Ornitholestes) depicted as catching the primitive long-tailed, toothed bird. From Dinosaurs *by W. D. Matthew.*

Central Alberta during Upper Cretaceous time. Hooded duck-billed dinosaur swimming in a bayou. Flat-headed duck-bills on sandbar and feeding on rushes in the swamps. After B. Brown
Courtesy American Museum of Natural History

Canadian Dinosaurs

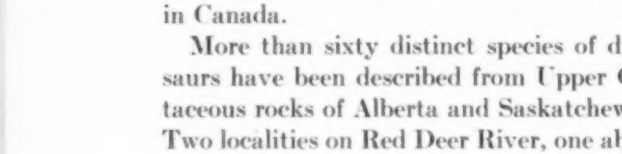
None of the large amphibious dinosaurs (Sauropoda), nor the very primitive forms, has yet been found in Canada. The rocks from which our dinosaurs are collected are delta deposits of Cretaceous age, whereas most Sauropoda and the primitive forms lived during earlier periods and in different habitat. Many other kinds, particularly those found in Europe, have not been found in Canada.

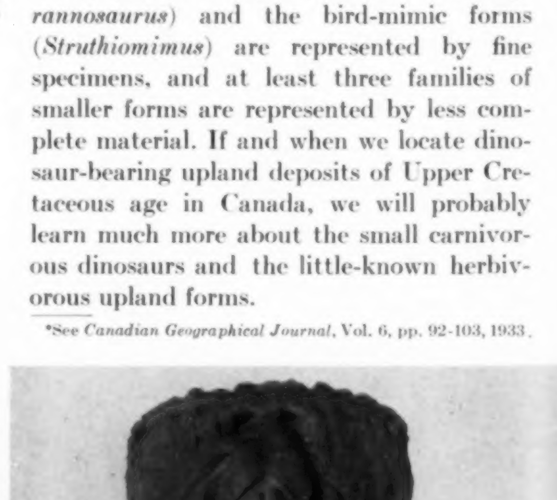
More than sixty distinct species of dinosaurs have been described from Upper Cretaceous rocks of Alberta and Saskatchewan. Two localities on Red Deer River, one about 120 miles east of Calgary, the other above Drumheller, have yielded most of these. Fairly complete skulls or skeletons of many species are known, while of others only parts of the skeletons have been found. In the collections are also many fragments which are known to represent undescribed forms but which are not sufficiently complete to serve as the type of a new species. Most of these species were smaller forms which probably inhabited the uplands. In addition eight species of dinosaur tracks have been described from Lower Cretaceous rocks in the Peace River Canyon, British Columbia.* Some of these tracks are such that they could not have been made by any known North American dinosaur. Others were probably made by carnivorous dinosaurs not greatly unlike some of the known forms. It is evident that many species of dinosaurs which lived during the Cretaceous are as yet undescribed.

Carnivorous Dinosaurs: The huge flesh-eaters (*Gorgosaurus*, *Albertosaurus* and *Tyrannosaurus*) and the bird-mimic forms (*Struthiomimus*) are represented by fine specimens, and at least three families of smaller forms are represented by less complete material. If and when we locate dinosaur-bearing upland deposits of Upper Cretaceous age in Canada, we will probably learn much more about the small carnivorous dinosaurs and the little-known herbivorous upland forms.

*See *Canadian Geographical Journal*, Vol. 6, pp. 92-103, 1933.

Below:— Hooded duck-billed dinosaur skull modelled by C. M. Sternberg. Part of the left side of the hood is cut away to show the winding narial passages, an underwater feeding adaptation. The mouth opening was much smaller than in the carnivores.





Right:— The predentary is an extra bone in front of the lower jaw bones (dentary) and is not found in any other order of reptiles. The lower figure shows the magazine-like arrangement of the teeth in the dentary of a duck-billed dinosaur.

Skeleton of hooded duck-billed dinosaur in the rock about seven miles southeast of Manyberries, Alberta. All of the tail and much of the left side of the skeleton was eroded away before discovery.

The huge carnivores were the culmination of a long line of large, lowland forms. They were by far the largest flesh-eaters that ever walked the earth and were the tyrants of the everglades. Some were over forty feet in length, had a huge head and four-foot jaws, carrying lance-shaped, recurved teeth up to six inches in length. They walked on powerful hind limbs, and, in an upright pose, the head would probably reach twenty feet above the ground. The hind feet were bird-like, and the three powerful toes of each foot carried the weight. The other toe (No. 1) had shifted toward the back of the foot and might have aided in grasping prey. All toes were tipped with sharp recurved claws. The front limbs were ridiculously small and quite useless. Only the first and second fingers remained functional and these were too small to have assisted much in either feeding or fighting. Such huge carnivores could only have survived in a country where there was an abundance of large herbivorous animals, and the extinction of the large plant-eaters spelled the doom of the tyrant carnivores.

The "Bird-mimic" dinosaurs are so named because, in general build, they suggest a large struthious bird with a long tail but without feathers. The neck was long and the small, lightly-built head was without teeth. Although these dinosaurs belonged to the same order as did the fierce flesh-eating forms, they had evolved new feeding habits as shown by the loss of teeth. We do not know on what they fed, but several suggestions have been made, e.g., shell-less invertebrates, insects, honey, fruit, and even the eggs of other dinosaurs. The front limbs were long and slender, and the three, long, narrow fingers could have reached into cavities to extract insects, honey or other food. The long hind limbs and feet were adapted for running rather than for grasping as was the case of all the true carnivorous dinosaurs. Other forms were very slender and the bones were hollow and very thin-walled. One of these was smaller than a house cat.

We have no positive evidence as to the integument of the carnivorous dinosaurs, but, since we have searched diligently and no impressions have ever been found, it is believed that the skin was smooth or covered with very small scales.

Herbivorous Dinosaurs: There were at least five distinct families of plant-eating dinosaurs living in Alberta during Upper Cretaceous time. Three of these families inhabited the deltas, swamps and river flood-plains, but it is probable that the others were upland forms. In all of these there was

Skeleton of horned dinosaur in rock of Edmonton formation, west of Morrin, Alberta. The carcass was buried before any of the flesh was devoured or decayed.

an extra bone in front of the lower jaw bones, known as predentary. This bone is not known in any other order of reptiles.

The duck-billed dinosaurs, so named because of an expanded beak like the bill of a duck, are the most abundant in the collections and the best known. This is not only because they were very numerous but also because they lived on the deltas and in the bayous and, therefore, many of them died in or near the water where there was a good chance of the skeleton being buried and preserved. We have found several skeletons lying on their back, with the head under the shoulder, which seems to indicate that after the animals died in the water the carcass was floated, by expansion of gas in the abdominal cavity, and finally came to rest in some backwash or on a sandbar or mud-flat out of reach of the carnivores. Rapid deposition of mud and sand covered the carcass before the flesh decayed, or, in cases where the skeleton was disarticulated, the bones were left close together and soon covered by fresh deposits of sand and mud. We collected one specimen which seemed to have been caught in quicksand, and the nose was pointed upward as if gasping for breath. Where the articulated skeleton is preserved, the impression of the skin is often found on the fine sandstone or shale, and in one instance the impression of the horny beak was preserved. The chitinous substance which makes up the hornsheaths, claws, beaks, and scales is not fossilized, but often impressions are as perfect as the scales themselves. Besides the more or less complete skeletons or skulls, there are a great many extensive "bone-beds" or layers where thousands of bones, teeth, turtle shells and pieces of wood had been thrown upon a beach by waves or carried onto a mud-flat by flood waters. These bones are from disarticulated skeletons, and there is no proof that any two of

those found together are from the same individual. Many of them show signs of having been tossed about by waves or rolled along the river bottom.

More than a dozen different species of duck-billed dinosaurs are found in Western Canada. The adults of these ranged from about twelve to forty feet in length, almost half of which was tail. They were well adapted to life in the water though, of course, had to come to the surface to breathe. They were mainly bipedal, and the powerful hind limbs could support the animal whether on dry land or wading in the swamp or bayou. The toes terminated in hoofs, each of the three on the hind feet being as large as the hoof of a horse. The hoofs on the front feet were much smaller and on some toes not developed. This would suggest that he was losing them from lack of use. All four feet were webbed and the high narrow tail was well adapted for swimming. The skin was thin and composed of small non-imbricating scales. The scales resembled those of the modern Gila Monster though they were relatively much smaller. The thin skin and absence of any means of defence, coupled with the webbed feet and swimming tail, indicate that these dinosaurs spent most of their time in the swamps or at least took to the water for protection from the big carnivores.

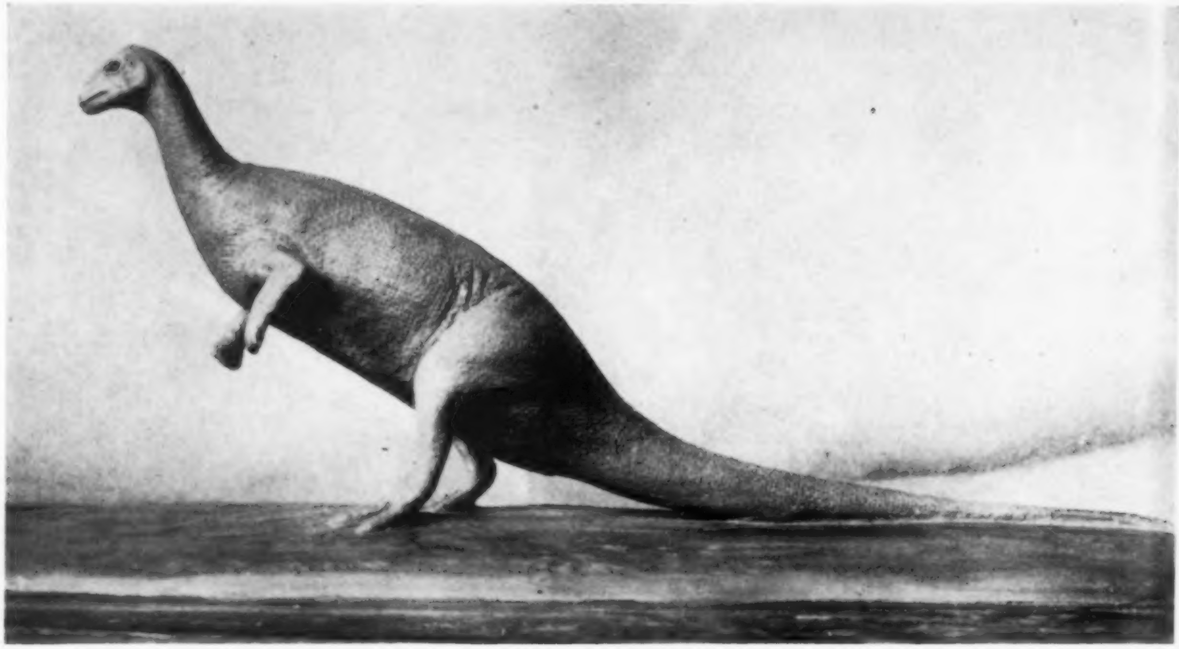
Each of the four jaws contained from 200 to 400 slender teeth. These were arranged in a magazine of vertical as well as horizontal rows and only about one-third were in use at a time, but, as these wore out, new ones grew up to take their place. Unlike mammals, reptiles do not have highly specialized teeth with distinct roots, nor are they confined to two sets, but throughout life new teeth are developing to take the place of those that wear out. The lower jaw passed inside the upper, and the teeth sheared the rushes and other swamp plants after they had been nipped off by the duck-like beak.

The hooded duck-billed dinosaurs had developed a specialized breathing arrangement as an aid to underwater feeding. The premaxilla (the bone which surrounded the external nares) was extended and folded to surround the narial passages. This thin, extended bone grew back and up to form a hood-like development on the top of the head and pushed the nasal bone back up over the frontal. Within this expanded premaxilla the elongated narial passage made one or more loops, thus trapping air to prevent water entering the lungs while he was feeding under water.

The horned dinosaur group included forms which ranged from about five to thirty feet in length. The most noticeable feature is a very large head surmounted by three horns and extending back over the neck and shoulders as a great crest or cape. The head,

Right:—Horned dinosaur skeleton, wrapped in burlap and plaster, being packed for shipment to Ottawa. This block weighed 3,200 pounds.

Below:—Calgary Zoological Society employees finishing life-sized, concrete model of horned dinosaur (Chasmosaurus) in a Calgary park. The scale pattern is being worked on the skim-coat.



Restoration model of small-headed upland dinosaur (Thescelosaurus) modelled by C. M. Sternberg.

including the crest which is made up of the extended parietal and squamosal bones, was equal to about one-third the total length of the animal.

Horned dinosaurs were habitually quadrupedal and the limbs were very heavy and sprawly for a dinosaur. The back was broad and the body was massive and low-set. The tail was much shorter than in the duck-bills, and there is no evidence that the horned dinosaurs were swimmers. Their protection lay in the great shield-like crest and the long, sharp horns and powerful, pointed beak. There is evidence to show that they congregated in small areas from which other dinosaurs were excluded. The skin was composed of scales somewhat like those of the duck-bills but larger. Some of the scales were two inches across. In the early evolution of this group, bars from the parietal and squamosal bones grew backward to give greater area for attachment of the powerful lower jaw muscles. These bars later developed into the shield-like crest. The first horn to develop was over the nose, then, later, small horns developed over the eyes. By the close of the Cretaceous period all forms had very large horns over the eyes and the nasal horn was relatively much shorter. In *Triceratops* (three-horned face) the brow horns were over three feet long and there were no openings in the great shield-like crest. In some individuals the head was nine feet long. When the nose was lowered and the crest thus elevated, "horny face" was well shielded against attack from even the huge carnivores.

The armoured dinosaurs were low-set, heavy-boned quadrupedal animals with short, very massive limbs and stubby feet. All members of this family were more or less encased in dermal armour of bony scutes in the skin. In some species the scutes were high-keeled, thick and over a foot long, while in others they were more plate-like with only slightly elevated keels. The large scutes were arranged in rows on the back and sides and between these were smaller ones. The under parts were protected by small shapeless ossicles in the skin. In some forms the tail terminated in a club-like mass of fused dermal scutes. Except for size, these dinosaurs somewhat resembled the little desert lizards known as "Horned Toads" though they were less flattened and the head was relatively smaller. A fifteen-foot animal would stand about four feet high but over five feet broad at the hips.

The teeth were very small and weak with pointed, compressed crowns, and were not suitable for masticating tough vegetation.

One genus had lost the teeth completely and developed a crushing plate on each jaw. They may have fed on tubers or soft roots of swamp plants or on soft-bodied invertebrates or even on insects. Although they were very heavy, the broad body and short limbs would enable them to slither through the swamps, much as turtles do. If he were caught on dry land he could drop flat on the ground, and the carnivorous dinosaur could not easily penetrate the bony armour. Most of the skeletons found in the delta deposits are preserved lying on their back indicating that, as the carcass floated, it was turned over by the heavy plates of bone on the upper part of the body.

Upland Forms: At least two families of herbivorous dinosaurs found in Alberta are believed to have inhabited the uplands. One group is known as the dome-headed or thick-skulled dinosaur. They ranged from five to to about fifteen feet in length, were mostly bipedal and without horns or armour, but with a greatly thickened skull. As the huge carnivores probably lived in the swamps, these upland forms had only the smaller carnivores to contend with. Their hind limbs were long, and the four toes were tipped with narrow hoofs which were adapted for running on dry ground. It is probable that they were fairly swift. The head was rather small, but the bones forming the top of the skull were dome-shaped and very thick. In one species, in which the head was about eight inches long, the bone over the brain was three inches thick. In a form found in the United States, but not yet found in Canada, the dome was nearly nine inches thick. The purpose of this great thickening of the skull roof is not understood.

Two genera of the other family are represented by fairly complete skeletons from Red Deer River, but only one specimen in each case is known. No popular name has been applied to these forms, but they might be called the small-headed, upland dinosaurs. *Thescelosaurus*, collected from the Edmonton formation northwest of Rumsey, Alberta, is best known. It was about eleven feet long. The head was less than eight inches long, the bones were quite thin, especially those over the brain; the body was fairly broad; the hind limbs moderately long and powerful; the fore limbs were short, and the five toes had tiny hoofs which suggests that they sometimes carried part of the weight. However, the long, powerful hind limbs seem to indicate that he was mainly bipedal. The tail was very long, and stiffened in older individuals by ossification of the long tendons.

In this family as well as in the dome-headed forms, the bones in front of the upper jaws, the premaxillae, possessed teeth as in the carnivorous dinosaurs. In most herbivorous dinosaurs the premaxillae were toothless and covered with horny sheath. The presence of teeth in the premaxillae in these two families is regarded as a primitive character. The teeth in the jaws resembled those of the armoured dinosaurs but were relatively larger and better adapted for a vegetable diet though little is definitely known of their feeding habits. Also, little is known of the ancestry of these upland forms.

Skeleton of an eleven-foot, small-headed, upland dinosaur (Thescelosaurus) *mounted in original matrix with all bones in position in which they were found. Missing parts were restored in plaster of lighter colour than the bones to distinguish them from the original fossil.*

Discovery and Collection

People often ask, "How do you know where to dig ?". The answer, of course, is that we do not dig until we have located a specimen. Throughout approximately 60,000,000 years the skeletons which were buried in the deltas have remained undisturbed. The mud and sand have become shale and sandstone while they were settling below sea-level and subsequently elevated to 2,000 or 3,000 feet above sea-level. Throughout all this time the skeletons did not see the light of day. Perhaps hundreds of feet of marine, fresh-water, or wind-blown deposits overlay the delta deposits at one time or another, but these have been eroded away, and once again the ancient deltas are exposed. Throughout the countless ages, water percolating through the rock dissolved certain minerals which were carried in solution, and, as it worked through the bone, certain cell walls were dissolved and replaced by the minerals which were carried by the water; thus the bone was replaced cell by cell. The bone is then said to be fossilized or petrified. In many cases the replacement is so perfect that the fossil contains the detail of a modern bone.

Quite recently, geologically speaking, the Red Deer and other rivers have cut gorges into the old deltas, and, with smaller streams running in from the sides and normal erosion by rain, frost and wind, badlands have been carved out. The term "badlands" is used for a section of creeks, gullies, ridges, buttes and hillsides from which all soil and vegetation have been eroded, thus exposing the ancient strata. As the rock wears away the tip of a bone may become exposed, and this is what the "fossil hunter" calls a prospect. If the specimen is not discovered and collected, the bone or eventually the whole skeleton will be weathered out and destroyed. Many of the prospects lead to only a single bone, a section of the tail or a disarticulated jaw, but occasionally one leads to a fine skull or perhaps a complete skeleton. No doubt hundreds of skeletons have been destroyed by erosion and thousands of specimens are buried so far from the surface that they will never be seen. The experienced fossil hunter knows, when he finds a prospect, whether it is merely a scattered bone, or whether it is leading toward the head, and perhaps promises a complete skeleton. It is not uncommon to find a skeleton of a duck-billed dinosaur without the head and front limbs. The explanation probably is that as the carcass floated around, the head and fore limbs dropped off, while the rest of the skeleton was still held together by the stronger ligaments.

When the prospect is located, the specimen is outlined by the use of hand pick, awl, small chisel, and whisk broom. A certain amount of rock is always left around the bones for protection while they are being removed from the field to the laboratory. If skin impression is preserved, an extra layer of rock must be left. If the skeleton is large, it must be divided into sections as it is difficult to handle blocks of more than 2,000 pounds. The head and neck may go in one section, the front limbs, the hind limbs, and the tail in others. If possible, the body portion is taken up in one section, but sometimes this is not possible because of the size. The more breaks that one makes the more the specimen is injured. In the early days of fossil collection the bones were dug out and wrapped in paper and then, as far as possible, they were pieced together in the laboratory, but very much information is lost when specimens are collected this way. Such information as skin, proper articulation of bones, number of joints or toes, etc., was only obtainable in the field before modern methods of collection were introduced.

When the sections are outlined and undercut, each is wrapped with strips of burlap dipped in fluid plaster. If necessary, sticks are inserted to give greater strength, much as the doctor uses splints in the cast on a broken arm. When the plaster is set, the section can be turned over and the wrapping completed, then the sections are packed in specially constructed boxes and shipped to the museum. In the museum laboratory the wrapping is removed and the slow, careful preparation is commenced. If the skeleton is articulated, it may be decided to mount it in

Above:—Dinosaur tracks in Peace River Canyon. One hundred and sixty individual tracks, representing four species, were observed on this rock shelf.

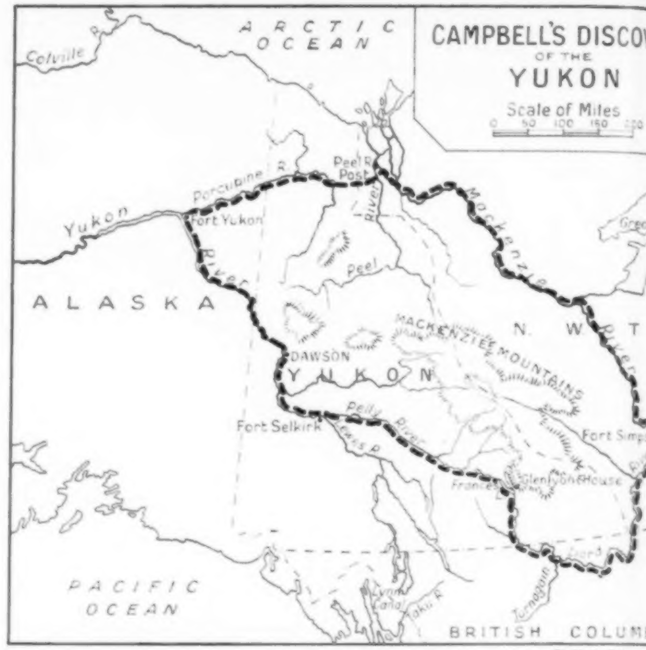
Track of small carnivorous dinosaur. The dinosaur which made this track was about six feet long.

what is called a panel mount where the bones are left in the original rock and position in which they were found. In this case the sections will be refitted and the whole mass supported so as to keep it together. Such mounts can be studied by future generations, and there is no question about the number of vertebrae in the back or number of joints in the toes or the proper positions of each because they are articulated as they were when the animal died. In some skeletons the bones are disarticulated or are not suitable for a panel mount or perhaps we wish to show the animal in a walking or standing pose. In this case the bones are separated, cleaned, posed and supported by a framework of iron bars or rods.

It is not possible to state definitely what caused the extermination of the dinosaurs. Perhaps great changes in physical conditions at the close of the Cretaceous, the development of the more intelligent and active mammals, and the old racial age of the dinosaurs were the most important factors in wiping out this interesting group. It is believed that a race or order can become old and weak the same as an individual. Though the dinosaurs became extinct at the close of the Cretaceous period, it must not be inferred that they disappeared overnight. During the closing years of the Cretaceous the number of species and individuals was gradually becoming fewer, although more highly specialized and gigantic. Large specialized forms are easily exterminated if there is a change in habitat or food supply.

Campbell Of The Yukon

by LAWRENCE J. BURPEE



C.G.S. Map

ON A MIDSUMMER DAY in 1840, Robert Campbell, of the Hudson's Bay Company, stood on a high bank and saw "a large river in the distance flowing North-West". He named it the Pelly, and the Pelly it still is, although Sir George Simpson, the Governor of the Company, said that it should bear the name of its explorer. Clambering down to the banks of the river, Campbell, in the flowery language of the period, "drank out of its pellucid water to Her Majesty and the H.B.C.". He then built a raft and floated down the stream a few miles, throwing in a sealed tin with a note of the discovery and the date, "with a request to the finder, if perchance the can should fall into anyone's hands, to make the facts known". Finally he completed the ceremony of taking possession in the name of the Company by carving "H.B.C." with the date on a tree, meanwhile flying the H.B.C. ensign overhead.

The identity of the river remained in doubt for some time, but there was no uncertainty as to the importance of the discovery. At that time there was keen rivalry between the Hudson's Bay Company and the Russian American Company for the control of the fur trade of the North Pacific coast and the interior country. Much might depend upon whether the Pelly emptied into the Arctic or the Pacific. Thomas Simpson who, three years before, had found the mouth of a large river on the Arctic coast west of the Mackenzie, and named it the Colvile, was convinced that Campbell's Pelly was the Colvile. Sir George Simpson, in his letters to Campbell, develops a variety of theories. In 1841 he thinks "the stream you are upon falls into the Pacific". Two years later he has reached the conclusion that "the river in question is the Tako falling into Lynn's Canal". In 1844 the Governor is hot on the trail. He offers two alternatives, "Pelly River, from what you say of it and from an examination of the chart you have sent me, is either Turnagain or Quikpok". It was not Turnagain, but it was Quikpok, or Kwikhpak, for that was the name by which the Russians knew the Yukon. Campbell himself says that he was always of the opinion that the Pelly and the Yukon were one, but it was not until 1851, when he had explored the river down to the mouth of the Porcupine, that he was convinced that the Pelly was the Yukon.

Meanwhile, having made his original discovery, he returned over the height of land to his trading post on Frances Lake, which he had named Glenlyon House, in memory of his boyhood home in Scotland. Campbell, to whom dangers and discomforts were part of the day's work, describes his journey from the Liard River to Frances Lake and the Pelly in matter-of-fact terms, but that route

became so notorious that the Company's men, when they signed their engagements, always tried to have it excluded.

In 1843 the explorer returned to the Pelly, built canoes at the place where he had first seen the river, and paddled downstream until he came to the forks of the Pelly and another large stream which he named the Lewes, the former called after the home Governor of the Hudson's Bay Company, and the latter after John Lee Lewes, a Chief Factor. On his way down, Campbell gave names to a number of the tributaries of the Pelly, and it is pleasant to recognize their association with his boyhood days in Perthshire (described by Sir Walter Scott as "the fairest portion of the northern kingdom"), and particularly in his native glen. Campbell's map of his discoveries has been lost, but George M. Dawson, in his 1887 Report on the Yukon, provides a map in which he has incorporated much of the information furnished by Campbell to Arrowsmith, including place-names. Here we find such names as Earn, Tummel and Orchy, rivers, lochs and glens that were very dear to this sturdy son of the Campbells of Breadalbane. Remember the lament of the MacGregors:

Glenorchy's proud mountain, Colchurn and her towers,
Glenstrae and Glen Lyon, no longer are ours!

At the forks Campbell met a party of Knife Indians, who had never before seen white men, but were quite friendly. They urged him to go no farther. The tribes below were so savage that they would not only kill him but they would eat him. Campbell, who understood Indian character, and as a matter of fact got along very well with them, was not impressed, but his men were thrown into a panic. However, he was not equipped to go on down the river at this time.

In a letter written in June, 1844, Simpson had suggested the forks of the Pelly and Lewes as a suitable site for a trading post. Conditions in the fur trade stood in the way, and it was not until 1848 that Campbell built Fort Selkirk at the forks. His immediate superior at Fort Simpson, Murdoch McPherson, took a sour view of the Pelly adventure and, while he could not openly oppose a project approved by the Governor, made it very difficult for Campbell to go on with it.

In 1851 the explorer received definite instructions to continue his discoveries. He left about the beginning of June, and, visiting a number of Indian villages on the river below Fort Selkirk, found the natives, as he had expected, neither bloodthirsty nor unfriendly. They were equally astonished at seeing the white men and their boat. "All our accoutrements—even the simplest articles—were a mystery to them." Their only arms were bows and arrows; "their substitute for axe and knife was of bone or stone", their 'kettle' was made of the small fibres of the roots of trees which became waterproof after a time.

Campbell, after he had travelled some distance down the river, was told by the Indians that he was approaching a place where there were white people like himself living in a fort. It proved to be, as he had hoped, Fort Yukon, built by Alexander Hunter Murray at the mouth of the Porcupine in 1847. It had been already established that the Porcupine emptied into the Yukon. "I had thus the satisfaction", says Campbell, "of demonstrating that my conjectures from the first, in which hardly anyone concurred, were correct and that the Pelly and the Youcon were identical."

Campbell travelled up the Porcupine and over the mountains to the Mackenzie, and up the Mackenzie to Fort Simpson at the mouth of the Liard, where he was received with astonishment, the only known route from Fort Selkirk being down the Liard, not up the Mackenzie.

The following year a party of treacherous Chilkat Indians came down the Lewes from the coast. Campbell, who was almost alone at Fort Selkirk, managed to escape, but the post was looted. The Company decided to abandon the Pelly as too dangerous to be profitable, greatly to Campbell's disappointment, who had planned to explore the Lewes.

Small shrubs atop the larger flowerpot, some 46 feet above the water, help to give the impression of a vase. The shipping lanes are near-by.

Flowerpot Island

by LYN HARRINGTON

Photos by Richard Harrington

"FLOWERPOT ISLAND! How quaint! Where did it get that pretty name?" asks the stranger. And though many might answer that question, relatively few know how interesting is this island with the picturesque title—that, besides having the two stone "flowerpots" which provide its name, it is a National Park, has a government caretaker, a lighthouse, and a number of fascinating deep caves.

Flowerpot Island is somewhat triangular in shape, like a scone with a bite taken out of one side. It lies about four miles to the northeast of the fishing village of Tobermory, off the tip of the Bruce Peninsula. Only 500 acres in extent, mostly rock, it is covered with dense northern forest, while the green waters of Georgian Bay lap its shores. It is one of the thirty islands included in the Georgian Bay Islands National Park.

Any one cruising in these waters would have no difficulty in mooring at the Government dock there, or even on one of the ledges close to the flowerpots. The only other course is to hire a motor-boat in Tobermory. We had planned to paddle over to the island, but there are no canoes for rent, the waters being considered somewhat dangerous. Barney, our genial guide, covered the distance quickly in his launch, pointing out the many islands round about: Bear Rump, Echo, the Otters, and Cove Island with its famous lighthouse.

As we approached the shore, we realized that what appeared to be gleaming white sand was actually the large pebbles and flat limestone so often found in these islands. One side of the island is rather low, while the opposite shore rises abruptly to about 300 feet above the water. This coastline is full of fissures and cracks, little bays and rocky amphitheatres.

As we rounded a little promontory, we came upon the two stone formations, some distance apart. At the foot of the larger, the water was deep enough for the boat to make a landing directly beneath the bulge of the rock. Countless centuries of weathering have cut these strange pillars away from the bluffs behind them, and there they stand, heavy at the top and slender at the base.

They do indeed resemble giant flowerpots, especially the taller, which has small trees growing in the cracks atop it, some 46 feet above. Twisted cedars cling to the sides of the smaller pot, defying the fierce winds of Lake Huron. This is the sturdier of the two, having a thicker stem, and is said to be 34 feet high. On the larger pot, the surface facing the water has been carved by frost and wind into stern features, resembling those of the weird statues of Easter Island, in the South Pacific. From the side view there is yet another human profile, chiselled out by these artisans of nature.

Layers of rock, much harder toward the top, form these huge urns. In geological phrasing, the lower part belongs to the unsubmerged edge of the Niagara cuesta, capped by huge masses of the Lockport dolomitic formation. Many horizontal and vertical cracks give an impression of brickwork, and it is true that man has taken a hand in reinforcing the base of the larger pot, to maintain it against the destructive action of erosion. For what the elements have created, they are assiduous in destroying. Scientists have spent much time here exploring the curious variations of the earth's surface.

We had no desire to climb either of these rock vases, which seem to be supported on such slender stems, but evidently it has been done.

"Standing on the top of that there tallest one, is just like standing on a swaying load of hay", declared Barney, "I know for I've tried it. You don't feel safe."

The flowerpots are the spectacular attraction of the island, and therefore the best

Flowerpot Island, showing two "flowerpots" on the eastern shore—Georgian Bay Islands National Park.

The entrance to an "open" cave, 200 feet above the beach

Thick northern forest conceals the entrances to the caves and covers the entire island.

known, but the caves high up in the rocky cliff are equally fascinating. One clambers over the blocks of limestone, which form massive steps up the face of the bluff, then along a woodland trail, tangy with the odour of evergreens. Even though the climb is steep the effort is well repaid. More than 200 feet below are the ledges of white rock, covered with clear turquoise water. Off toward the traffic lanes, yachts and freighters go by, unconcerned about this little island and its remarkable geology.

From the main trail, little side paths lead off to the best known caves, which are labelled variously, A, B, C, 1, 2, 3 and "the one at the lighthouse". There are others, not so close to the path, which are not named, nor even explored. At the entrances to some of the caves hang coal-oil lanterns, but the enthusiast should take along his flashlight.

In most of the caves, the constant drip of moisture has worn the ceilings and walls to relative smoothness. In others, it has wrought beautiful designs upon the rock walls, resembling draperies, frills and shirrings. There are numerous stalactites, and we found one that had become a pillar, about two inches thick and eight inches high. There are many crannies and crevices, arched domes and short passages. In caves where even a little daylight penetrates, little ferns have taken roots in the cracks of the rocks, and glow like emeralds in the moist obscurity.

The largest of the caves—"big as a small house"—has been closed to the public. Falling rocks have proved too much of a menace. In ages past, large rocks have slipped and are wedged by another huge one, to form the wall of one cavern. Here, overhanging rocks give the effect of being in a canyon; the under sides glow rosily, reflecting the forest floor, which is carpeted with dry pine needles.

In the untracked interior of the island live many of our smaller animals. Being a National Park, no shooting may be done except with a camera. A government caretaker lives on the island to watch for fires and any infringement of the law. He places out the stoves for picnickers each spring, keeps the dock and pavilion in repair, clears the paths to the caves, and no doubt has many other duties as well. The day we saw him he was busy painting the pipes for the outdoor stoves, but stopped to chat awhile.

The household at the lighthouse forms the rest of the population of Flowerpot Island. Thick fogs and numerous shoals necessitate many lighthouses, especially in waters frequented by freighters and fishermen. Standing high on the northeast corners of the island, it sheds its light over the Georgian

A rustic pavilion built by the Government stands near the dock.

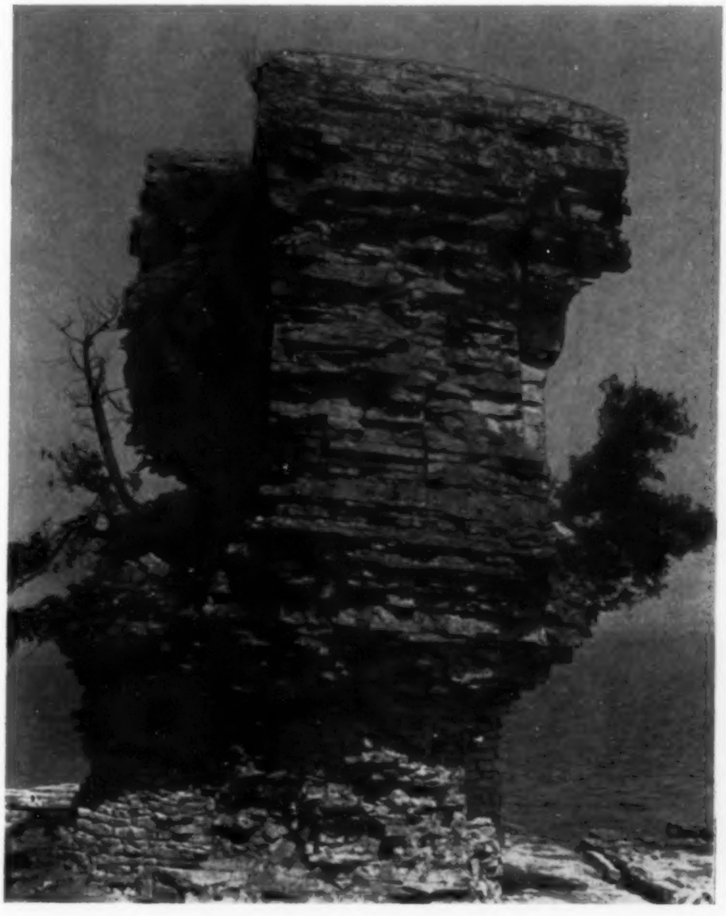
The lighthouse is an integral part of the Georgian Bay scene.

Bay, and its fog signal booms through the mist in response to passing vessels. One trail —between the dock and caretaker's cabin— extends along the north shore for about half a mile west of the lighthouse, while a second trail — also leading from the dock — extends southwesterly across a low divide between two ridges to the southwest shore of the island, a distance of nearly a mile.

Fear and superstition have gathered round the flowerpots, as around many other forms Nature has taken. It is said that the Indians have shunned the island from earliest times, and even to-day will not land there.

"Anything queer like that, the Indians won't go near it", we were informed.

It is strange to think that these unusual formations which have so repelled the Indians should prove such an attraction to the white man. Yet so it is. It is an island that has a lure for every nature lover, the fisherman, the geologist and the botanist— not to mention the picnicker.



Twisted cedars cling to the crags of the smaller flowerpot.

Booms swung from work trains were used to lay the cable alongside the railway track before it was erected on the poles. It is believed that this was the first occasion on which telephone cable was laid from a moving train.

The Newfoundland Project

Bell Men Erect 400 Miles of Cable and Pole Line for Military Use

by H. G. OWEN

LARGEST of the three major war projects undertaken by the Bell Telephone Company of Canada outside of its territory in Quebec and Ontario was the erection of more than 400 miles of pole line and cable across Newfoundland for the United States Signal Corps in order to interconnect various military and other defence establishments on the island.

The first quick survey of the job was made in April, 1942. Despite the most heartbreaking delays in obtaining supplies and exceptionally difficult working conditions, pole placing began in June, cable placing in August, and, by the fall, sections of cable were being lashed in place and connected at a peak rate of ten miles a day. Final testing was completed in the middle of a Newfoundland winter, and the completed job handed over to the United States Army in March, 1943, less than a year after the first Bell men visited the island.

Twenty thousand, four hundred native spruce and tamarack poles, averaging 20 feet in length with a minimum top diameter of seven inches, were supplied by the United States Army and erected under contract by the Par Tex Foundation Company. Out of every eight poles placed, two required supporting anchors or push braces, one was in rock that required drilling and blasting, one was in swamp and needed a swamp fixture. One pole left in muskeg sank eight or nine feet overnight. Pole placing alone took nearly eight months to complete. It is estimated that poles of this type will last not more than eight to ten years under prevailing conditions.

The route of the cable lies in an area subject to very severe weather conditions. Tales were told of gales blowing whole trains from the rails in Funnel Valley. In the previous winter, "glitter" swept down 60 miles of pole line as cleanly as if it had been mowed with a scythe. In the depth of winter, drifts may completely cover 30-foot poles and wires in places. An unusually heavy supporting strand for the size of cable was therefore required, and the cable was lashed directly to the strand with wire, instead of being suspended from it by rings. Cable was manufactured and supplied by the Western Electric Company.

The greater part of the line runs along railroad right-of-way. Already overburdened with wartime traffic, the railroad had great difficulty in delivering supplies, but by heroic efforts was able to supply four work trains, two of which were used to lay the cable beside the pole line while the train was in motion. It is believed that this was the first occasion on which a cable has ever been laid from a moving train.

Underground conduit was required at two places—one where huge storage piles of pulpwood were loosened by dynamiting, and one at a quarry where jagged pieces of flying rock from blasting operations might cut through the soft lead sheath. At another point, conduit was clipped to the face of a large dam. Four river crossings were made by attachments on the railroad bridges, and three by means of long span "H" fixtures. In one section, steel-tape armoured cable with frequent grounds was required to prevent interference from a paralleling high tension power line.

Repeater equipment for ten stations was supplied and installed by the Western Electric Company. About one hundred miles of additional cable was erected by the Western Union Telegraph Company on their poles, and other work on the project was carried out by the United States Army.

Eighteen camps of frame construction and two camps of combined frame and tent construction were erected by United States Army engineers solely for this job. Each accommodated about a hundred men, and at one time 16 were occupied at once. Altogether, about 330 Bell men were engaged on the job at various times, and 700 Newfoundlanders were employed by the two sub-contractors.

EDITOR'S NOTE BOOK

Born in Kansas, C. M. Sternberg began collecting dinosaurs in Wyoming in 1908. In 1912 he joined the staff of the Geological Survey of Canada and commenced work in the then little-known Red Deer River field. His life-time specialization in the collection and study of dinosaurs has won international recognition. Mr. Sternberg has had published a number of scientific papers describing over two dozen new species. His article, "Canadian Dinosaurs", provides a valuable supplement to "Prehistoric Footprints in Peace River" published in the February, 1933, issue of our Journal.

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Born in Canso, Nova Scotia, C. S. Beals, author of "The Practical and Commercial Value of Astronomy", studied physics at Acadia, Toronto and Yale Universities in addition to London University (Imperial College of Science and Technology), which he attended for two years, receiving a Ph.D. degree in physics and a D.Sc. in astrophysics from that institution. He was assistant professor of physics at Acadia University for one year, a member of the astronomical service of Canada for seventeen years, and is now Assistant Director of the Dominion Astrophysical Observatory, Victoria, B.C. In 1939, shortly before the war, Dr. Beals went to Paris on the invitation of the Foundation Singer Polignac to take part in a conference on scientific problems connected with novae, or new stars. During the war, from 1942 to 1943, as Provincial Gas Officer of British Columbia, he spent two years on experiments and in organizational work in connection with civilian protection against poison gas.

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Sub.-Lt. Florence Whyard, W.R.C.N.S., author of "H.M.C.S. *Conestoga*", has been attached to the staff of Naval Information at Ottawa since enlisting in May 1943. Her work as Public Relations Officer has taken her from coast to coast on visits to naval establishments, and she spent several weeks at the training ship in Galt. A member of the Canadian Women's Press Club and the Canadian Authors' Association, she had been doing newspaper and publicity work in London, Woodstock, Toronto, Fort Erie and Ottawa before enlisting as a Probationary Wren. Lt. Whyard, a graduate of the University of Western Ontario, earned a Limited Commercial Pilot's certificate before the war, and hopes to free-lance from the Northwest Territories with her husband when her job with the Navy is done.

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Lawrence J. Burpee, LL.D., (whose "Campbell of the Yukon" initiates a series of such accounts planned for publication in the Journal) has written a score or more books on Canadian history, geography and biography, in addition to contributing to many encyclopaedias and magazines—including the *Canadian Geographical Journal*, of which he was Editor from 1930 to 1936. He is at present editing the Journals of Robert Campbell for a New York publisher, while his latest book, *Discovery of Canada*, is to be printed by the MacMillan Co. of Canada at an early date. A Fellow of several learned Societies at home and abroad, Dr. Burpee, whose reputation as an historian is international, is a gold medallist of the French Academy and of the Royal Society of Canada. For the past 32 years he has been Secretary for Canada of the International Joint Commission.

AMONGST THE NEW BOOKS

Peoples of the U.S.S.R. by ANNA LOUISE STRONG
(MacMillans, New York, $2.75)

MISS Strong's long residence in Russia and her many books and writings on Russian topics have made for her a prominent place as an intepreter of the Soviets to the western world. The present book describes the various races which make up the Russia of to-day, their way of life, and the revolutionary changes of the last few years. There is little doubt that the Government of Russia has pursued a most enlightened policy in dealing with the non-Russian elements of her population: a policy that has aimed to develop, rather than destroy, their native cultures and to prepare them to

(*Continued on page X*)

(*Continued from page IX*)

take their places as full citizens of their respective republics. The book is thoroughly well written and enjoyable, but one cannot help but feel that Miss Strong views the whole Russian scene through rose-tinted spectacles, and that many of those ignorant nomads were not inducted into an orderly and industrious life without the use of some of those brusque methods of persuasion that have been in evidence in the execution of other Soviet politics.

The unfailing success of the plans for the development of these new areas, the procession of happy, smiling faces in every illustration, and the omission of any reference to the toil and tears that must have been associated with such radical changes, leave the reader with the feeling that he has again been given a nicely flavoured bonbon of propaganda rather than a factual account of things as they are.

* * *

Winged Peace by AIR MARSHAL W. A. BISHOP
(MacMillans, Toronto, $3.50)

WHEN Air Marshal William A. Bishop, V.C., D.S.O. and Bar, M.C., D.F.C., LL.D., Legion of Honour, Croix de Guerre, speaks about the air of yesterday, to-day, or to-morrow, he speaks as one having authority. One of the great, if not the greatest, fighting pilots of the last war, and almost the only survivor of that group of pre-eminent flyers who chased the Hun from the skies of 1918, he has maintained his interest in aviation and, in recent years, devoted his great gifts and prestige to the recruitment of the Royal Canadian Air Force. This introduction is unnecessary and redundant for any Canadian reader to whom the name Billy Bishop has been, for a generation, synonymous with the mastery of the sky, but it may serve to lend weight to his views of the possibilities and grave dangers that are even now being foreshadowed in the aviation of the future.

The first part of the book is devoted to a discussion of the global aspects of air transportation, followed by a modest and unassuming account of the author's own training in the last war, and the methods and exploits of other great pilots, particularly of his friend and associate, Barker. It is to be regretted his modesty prevented him from giving the reader more from his own record, which was surpassed by none. Written before the days of the V1 and V2 bomb, Bishop forecast those atrocious developments of air warfare and went even farther in foreseeing what they may develop into for the future. His appreciation of the politically powerful groups in the United States and Britain who wish to control post-war world aviation for their own financial benefit foretold the pitiable fiasco of the Chicago conference. In short, the few months which have elapsed between the writing and the publication of this book have confirmed his views that air power, unleashed in another war, would inevitably wreck our civilization, and that unrestrained and grasping competition in air transportation carries the virus of that other war.

From these premises Bishop advocates a world authority for the operation of global air services whose profits, if any, would go toward the support of whatever league or association may be established for the maintenance of peace. This is not offered as any easy compromise for the solution of a minor problem, but, in deadly earnest, as the only method whereby air power can be made the servant and not the assassin of mankind. Coming as it does from a man whose experience and authority are beyond question, this proposal cannot be lightly dismissed. It should be weighed and studied by men of good will throughout the world, whose hope is that they and their children can live their lives in peace, in order, and in quietude. A very fine book introducing a great proposal which may be considered by no means the least of the services that Air Marshal Bishop, V.C., has rendered to his country and to the world.

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The W.A.A.F. in Action
(Adam and Charles Black, London)

EIGHTY-SEVEN photographs which show the W.A.A.F. in action and the varied services they have performed in their association with the Royal Air Force during the battle of Britain and the great air offensive against the continent.

* * *

Alaska and the Canadian Northwest by HAROLD GRIFFIN
(W. W. Norton & Co., New York, $3.00)

MR. GRIFFIN is a young newspaper man who has been going north for the last ten years or more and has seen for himself much of the great development that has been undertaken under the forced draft of wartime necessity. The book appears to be a gathering together of a number of feature articles, interviews and so on without any very well marked plan, but it is ably written and, to a degree, informative. The author is perhaps too prone to take casual and optimistic statements at face value, or a little better, but the frontier has always been the abiding place of optimists, without whom there would be no frontier. There are sections on the tar sands of the Athabaska, the Peace River district, the Alaska Highway and Canol project, Whitehorse and Fairbanks, and a concluding chapter on post-war possibilities.

The author would have inspired more faith in his own judgment and knowledge of the country if he had omitted the account of a hair-brained escapade in which he, with two companions, walked from Skagway to Whitehorse rather than waiting for the resumption of train service interrupted by winter storms. The only equipment these adventurers had for such a journey appears to have been an abiding faith in the friendliness of the Arctic, and, reading between the lines, it is evident they were saved from a very dangerous situation, only with the exasperated help of the residents along the line.

P.E.P.

MAPPING FOR EVERYMAN

MAPPING, the step-child of the sciences in time of peace, becomes, in warfare, one of the essentials without which military operations can neither be planned nor executed. The air photograph has made it possible to map, in the greatest detail, territory occupied by hostile forces, and every modern army has a survey section prepared and equipped to turn out maps with a speed that seems incredible by peacetime standards. We have, for example, the record of a Canadian survey company plotting a complete map of a section of France in twenty-four hours and having it printed in four colours six hours later. Maps for civil use are equally important and are required for almost every phase of post-war planning, and Canadians may well hope that the present interest in mapping will be maintained until every corner of their own country is adequately covered.

General interest in maps and mapping is reflected in a number of books on the subject which are now appearing. These are directed not only to the student or specialist but also to those whose interest is only of a general character. This month the Journal has the pleasure of bringing to the attention of its readers six books on maps and map making.

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Military Maps and Air Photographs by A. K. LOBECK and W. J. TILLINGTON, (McGraw-Hill Book Co., $3.50)

THIS is designed as a textbook for those whose civil or military duties require them to use maps, but is of equal interest to the non-technical reader. It defines the attributes and uses of the topographical map or air photograph in a concise and simple manner, and relies, in the main, upon its hundreds of plates and drawings to establish the relationship between the map and the country it depicts. These plates are excellent in themselves and really constitute what might almost be considered a short course in physiography. In fact, it may be, that rather too much emphasis is placed on the interpretation of physiography to the neglect of other features of maps and air photographs. The text is so arranged that the explanation of each drawing is on the same page, and numerous exercises and problems are included. Excellent in plan and arrangement, this book should receive a very warm welcome from all who are interested in maps and geography.

Down to Earth, Mapping for Everybody
by DAVID GREENHOOD (Holiday House, N.Y., $4.00)

IN contrast to the first mentioned book, *Down to Earth* is intended to interest and delight the amateur in maps whose imagination is stimulated by looking at the graphical representation of the seas and mountains, the cities and countryside of far distant lands that he may never hope to see.

Mr. Greenhood introduces his subject with the elementary first principles of maps, describes their construction and the symbols and conventions employed for the representation of various topographical features. He discusses, possibly at too great length, the subject of projections, in which the problem of showing a curved surface on a flat plane of a map has long been a favourite playground of the mathematically minded. In general, this subject may be somewhat too involved for the ordinary reader who will, however, be amazed at the wide variety of shapes the world can assume under the hands of an imaginative projectioneer. The author goes on to tell his readers how they can make simple maps for themselves and describes the plane-table and other surveying instruments and their uses. The concluding section tells where and how to get maps and to form a map library.

The book is beautifully illustrated with hundreds of drawings by Ralph Graeter, art editor of *Life*, who must, himself, be a map enthusiast. An outstanding book, a credit to author, illustrator, and publisher, which will be a delight to amateur and expert alike.

Foreign Maps by EVERET C. OLSEN and
AGNES WHITMARSH (Harpers, $4.00)

A DETAILED description of the maps published by various countries, their characteristics and scales with translations of terms used in map legends and similar information. A valuable reference book for those who use maps extensively.

* * *

Essentials of Aerial Surveying and Photo-Interpretation
by TALBERT ABRAMS (McGraw-Hill Book Company, $3.00)

THE author, Mr. Abrams, is well known in both the United States and Canada as the president of a company engaged in the execution of air surveys. With the entry of the United States into the war, Mr. Abrams' organization undertook to train military personnel in map making and the interpretation of air photographs. The present book is based on the lectures and demonstrations given to these military classes. It is essentially a book of practical instruction which covers only enough theory to provide the student with a background and concentrates on teaching him how to make a map. The course includes practical surveying, the plotting and interpretation of air photographs, stereoscopy, the use of simple plotting instruments, the slotted template, and a final section on tri-metrogon charting. The book is copiously illustrated with photographs and diagrams and has a useful glossary and an index. A very practical and useful book.

* * *

World Maps and Globes by IRVING FISHER and
O. M. MILLER (Collins, $3.00)

A SHORT book devoted mainly to the description of map projections and the ever recurrent problem of depicting the curved surface on a plane. A useful summary of the subject.

* * *

Map Reading by ELAINE FORSYTHE (McKnight & McKnight, Bloomington, 60 cents)

A SERIES of nine lectures on map reading for school use. Illustrated with diagrams. —P.E.P.